INSTRUCTION BOOK

FOR

HYBRID CIRCUIT NETWORK

TA-255/TT

KNOWLEDGE IS FREEDOM

SCPA

SIGNAL CORPS PUBLICATIONS AGENCY

MANUFACTURED BY

LENKURT ELECTRIC CO., INC.

ORDER NO. 3280-PHILA-52

19 JUNE 1953

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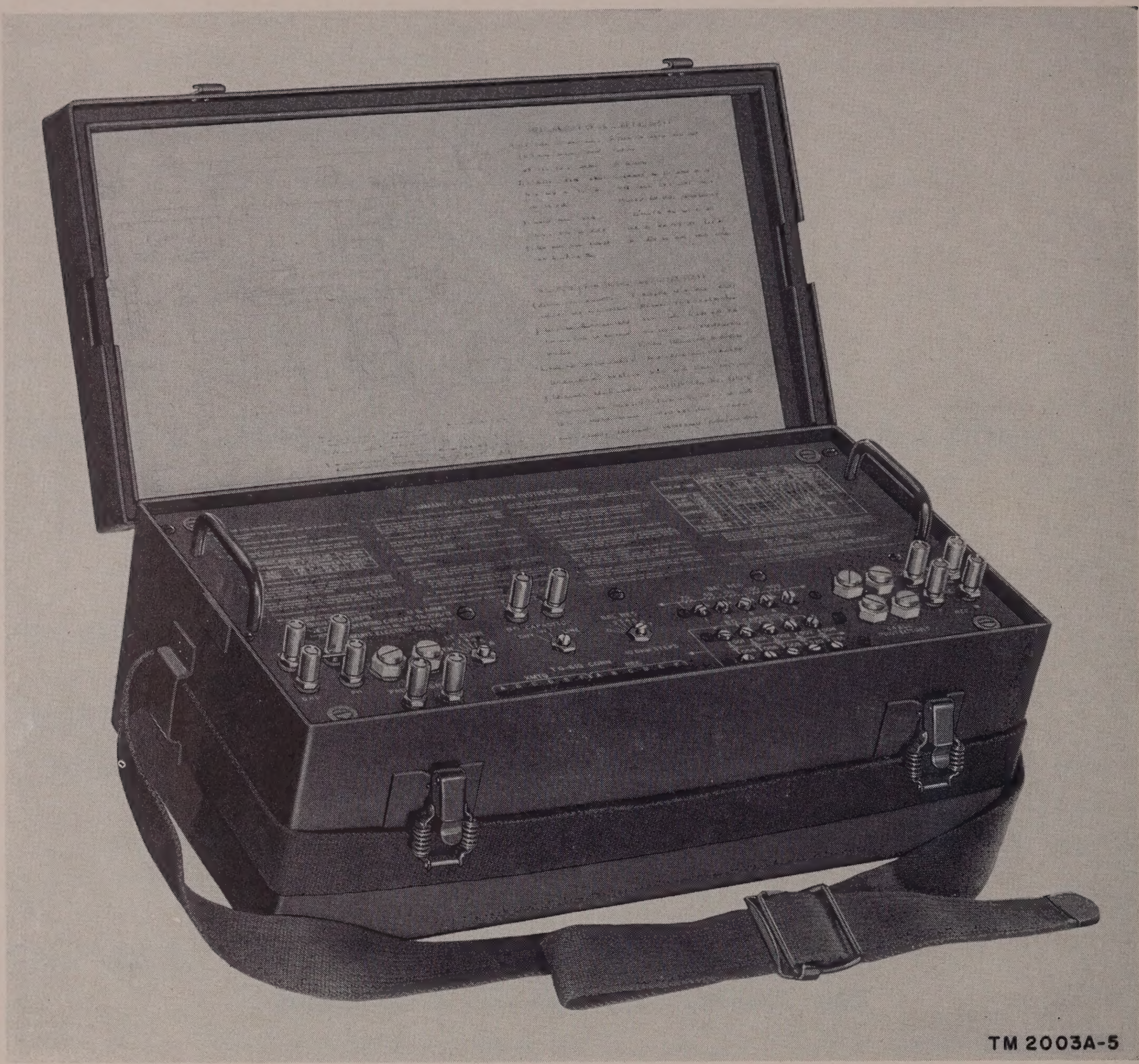


Figure 1. Hybrid Circuit Network TA-255/TT, front view.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. These instructions are published for the information and guidance of the personnel to whom this equipment is issued. They contain information covering the installation, operation, maintenance, and repair of Hybrid Circuit Network TA-255/TT (fig. 1).

b. This instruction book is prepared in six chapters and two appendixes. Appendix I contains a list of pertinent references, and appendix II contains an identification table of parts.

2. Forms and Records

The following forms will be used in reporting unsatisfactory conditions of Army materiel and equipment and in performing preventive maintenance:

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745-45-5 (Army), NAV DEPT SERIAL 85P00 (Navy), and AFR 71-4 (Air Force).

b. DA AGO Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700-45-5.

c. USAF Form 54, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700-45-5 and AFR 65-26.

d. DA AGO Form 11-238, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form.

e. DA AGO Form 11-239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form.

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Purpose. Hybrid Circuit Network TA-255/TT (fig. 1) is a portable unit used to connect either Telephone Terminal CF-1-A or CF-1-B or Repeater CF-3-A (all of which are designed for four-wire operation) to a two-wire line. In addition, two ground-return d-c (direct-current) telegraph circuits, or a ground-return d-c signaling circuit and one ground-return d-c telegraph circuit may be operated over the two-wire line.

b. Use. One Hybrid Circuit Network TA-255/TT is used at each junction of the two-wire and four-wire lines. The equipment is designed primarily for operation over open wire lines. In an emergency it may be used on Wire W-143 or on one pair of Cable Assemblies CC-358.

Note. Throughout this instruction book, wherever TA-255/TT is used, it will refer to Hybrid Circuit Network TA-255/TT. Reference to CF-1-(*) will refer to Telephone Terminals CF-1-A and CF-1-B. Reference to CF-3-A will refer to Repeater CF-3-A (carrier).

4. System Application

a. Use with Telephone Terminals CF-1-(*) and Repeaters CF-3-A. Figure 3 illustrates various ways in

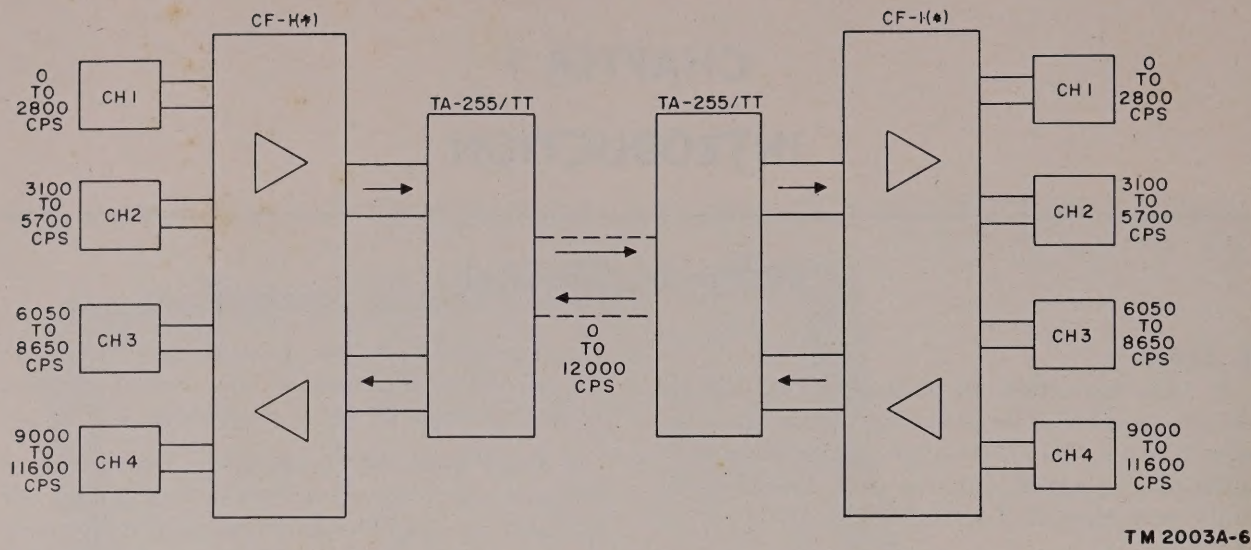


Figure 2. Block diagram, showing frequency-handling capacity of Hybrid Circuit Network TA-255/TT.

which a hybrid network is used in a carrier system using Telephone Terminals CF-1-(*) and Repeaters CF-3-A. Hybrid networks always are used in pairs; one is located at each end of the two-wire line regardless of the type of hook-up used. Either the TA-255/TT or Carrier Hybrid CF-7 may be used. Hybrid Circuit Network TA-255/TT is electrically identical to Carrier Hybrid CF-7. These units can be interchanged and used as pairs in a system. A and B, figure 3 illustrate the two units used as pairs in a system.

b. Use with Radio Terminal Set AN/TRC-3. Figure 4 illustrates the use of hybrid networks in a carrier system using Radio Terminal Sets AN/TRC-3. In this system, the radio transmitters and receivers merely form a link in the carrier system. This application ordinarily would be used to span some difficult terrain such as a water crossing. Figure 5 illustrates the use of hybrid networks with Radio Terminal Sets AN/TRC-3 to form a short distance single channel radio system. In this system, the hybrid networks must be located as close as possible to the radio sets so that the balancing network in the hybrid networks can balance the four-wire line. Under favorable conditions, it may be possible to locate the hybrid networks as much as a mile from the radio terminals and still maintain

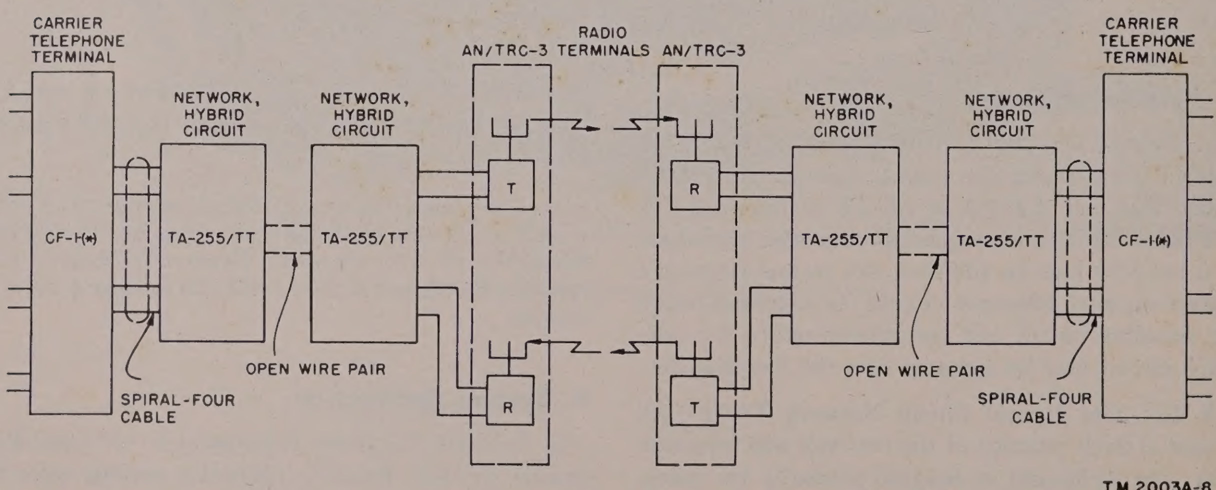
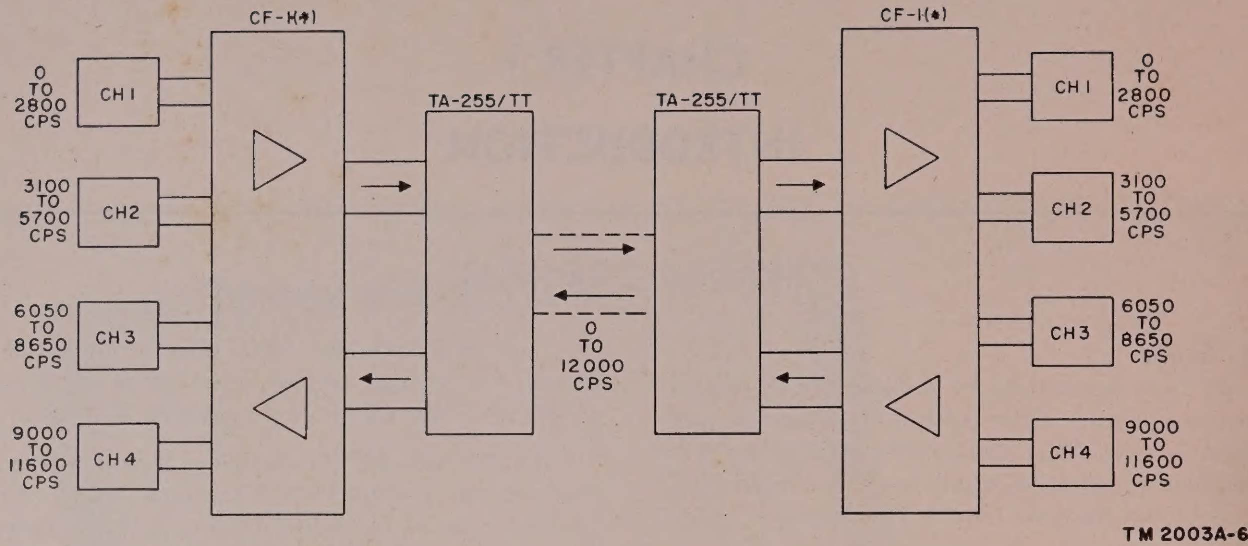


Figure 4. Block diagram, showing use of Hybrid Circuit Network TA-255/TT in a carrier system with radio terminal links.



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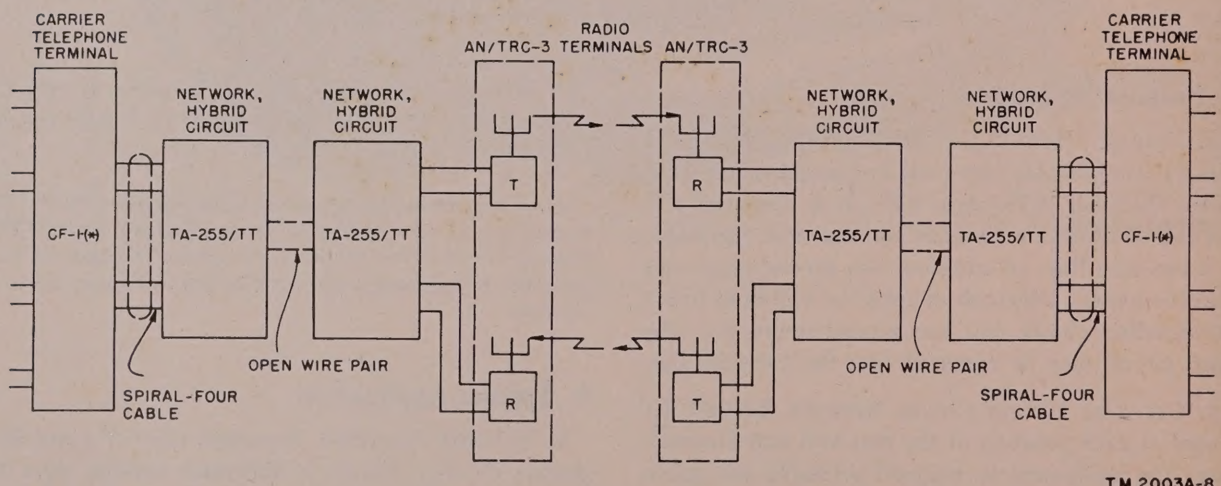

Figure 4. Block diagram, showing use of Hybrid Circuit Network TA-255/TT in a carrier system with radio terminal links.

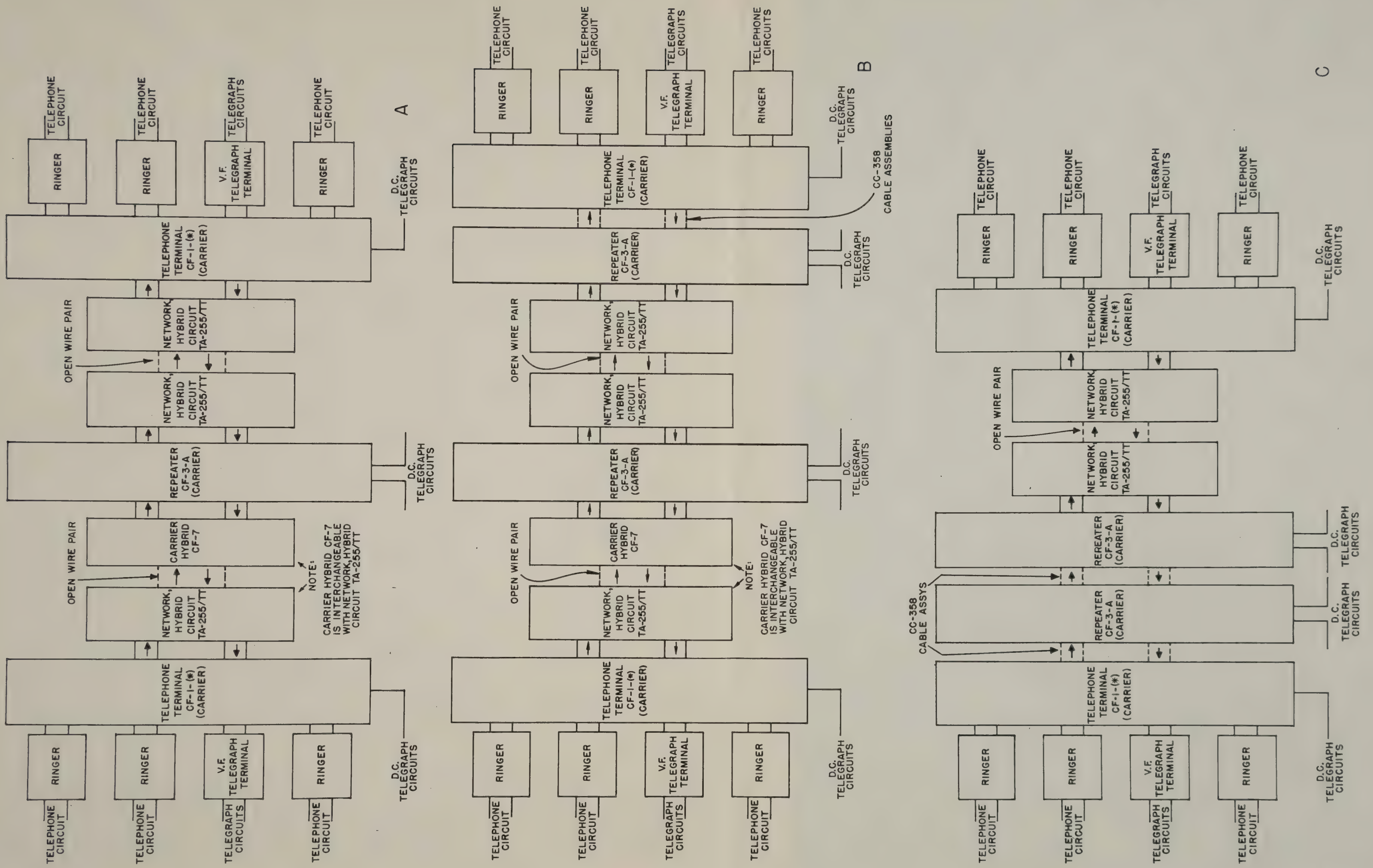

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Figure 3. System applications of Hybrid Circuit Network TA-255/TT, block diagrams.

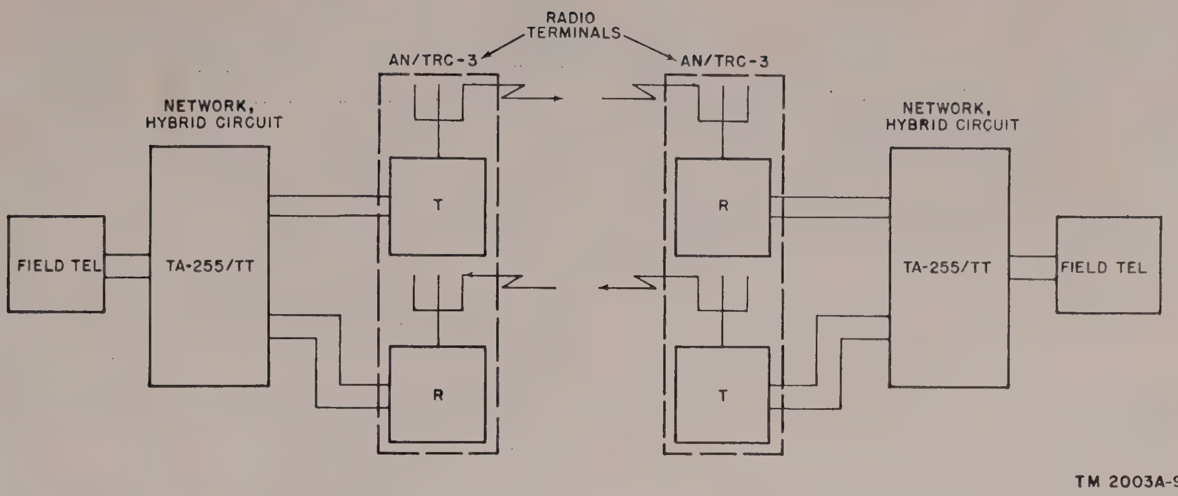

Figure 5. Block diagram, showing use of Hybrid Circuit Network TA-255/TT in a short distance single channel system with radio terminals.

a usable circuit. However, this should be attempted only in cases of emergency.

c. Signaling Circuit. For maintenance of the system, a signaling circuit can be made available over one of the d-c composite circuits. This signaling circuit makes use of the arrangements normally included in the CF-1-(*) and in the CF-3-A. This circuit is designed for use with cable circuits and will be subject to certain limitations when used over open wire. In dry weather the signaling circuit will operate satisfactorily over open wire lines but in wet weather the open wire leakage may become sufficiently high to cause the circuit to be inoperative. In wet weather the signaling circuit should function satisfactorily from the carrier terminal at which the battery is applied to the next one or two repeaters. Beyond these points, the line leakage may prevent sufficient signaling current from reaching the following repeaters or distant terminal. Similarly, no signal can be transmitted back from these points since the signaling circuit will be grounded through the leakage path. When the signaling circuit is out of operation because of excessive leakage, some relief can be afforded by breaking the signaling circuit into two sections and applying a battery at each terminal and ground. This arrangement, however, provides no means for getting the signal past the intermediate point.

d. Phantom Circuit. Where two systems using hybrid networks are being operated over the same open wire pole line, a phantom circuit can be made available from a terminal to a repeater or between repeater stations. For satisfactory operation, however, it is necessary that all lines be of equal gage and construction. Figure 10 illustrates the use of the phantom circuit and the necessary connections.

5. Technical Characteristics

Types of signals transmitted	d-c telegraph and carrier telephone
Frequency range	0 cps (cycles per second) to 12,000 cps.
Number of circuits	Four 2-way carrier telephone circuits and two d-c telegraph circuits.
Distance range	150 miles with 080 copper-steel 40%. Refer to paragraph 11.
Power supply	None.
Location in system	At two-wire, four-wire junction.
Signal and alarm circuit	Can be carried through on one of the telegraph circuits.
Weight with carrying case	45 pounds.
Transmission loss	4 db (decibels).
Impedance:	
2W-LINE terminals	600 ohms.
XMTG terminals	600 ohms.
REC terminals	600 ohms.

6. Packaging Data

Hybrid Circuit Network TA-255/TT is packaged for either export or domestic shipment. For export shipment, the TA-255/TT is wrapped in protective paper and placed in an inner corrugated carton. It is

spaced in the inner carton by one inch thick corrugated spacers. The inner carton is covered with a heat-sealed moisture-vaporproof barrier and placed inside an outer corrugated carton. The outer corrugated carton is wrapped and sealed in a waterproof barrier and packaged in a wooden packing case. For domestic shipment, the waterproof barrier, outer corrugated carton, moisture-vaporproof barrier, and wooden case are omitted. The dimensions and weights of the TA-255/TT are listed in the table below.

	Height (in.)	Width (in.)	Length (in.)	Volume (cu. in.)	Weight (lb.)
Unpacked	7	10	18½	1295	45
Packed for domestic use	7½	10½	19	1495	48
Packed for export	16	16	28	7200	78

7. Description of Hybrid Circuit Network TA-255/TT

a. Hybrid Circuit Network TA-255/TT consists of a hybrid transformer arrangement, an adjustable balancing network, a variable building-out capacitor unit, a d-c telegraph composite set with two noise filters, and a low-pass filter. It is housed in a rainproof aluminum case and cover, finished in olive drab lusterless enamel. A removable web strap is provided for carrying the equipment. When the two catches on the back and the two catches on the front of the case are released, the back catches function as hinges and the cover swings back clear of the panel (fig. 1). The case cover is notched at each end for wire outlets and permits replacing the cover after wire connections have been made. The chassis may be removed from its case by turning the cam-actuated fastener pins at each corner counterclockwise and lifting the chassis out of the case by the two handles on the panel.

b. The panel mounts three rotary switches and three screw-down contact switches for placing the equipment in operation. All switches are slotted for screw-driver adjustment. Twelve compression-type binding posts are used for connections to external equipment. In addition, there are six removable protector blocks for protection of the equipment against damage from lightning or other abnormal voltages on the line.

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. SYSTEM LAYOUT CONSIDERATIONS

8. When to Use Hybrid Circuit Network TA-255/TT

a. The TA-255/TT is used in a carrier system where open wire pairs are at a premium. Wherever sufficient pairs are available, four-wire operation provides a more stable and less vulnerable system with wide latitude in make-up of the line wires. Therefore, when sufficient pairs are available, the hybrid network should not be used.

b. Hybrid Circuit Network TA-255/TT should be used with Radio Terminal Sets AN/TRC-3 when the radio sets form a link in a two-wire carrier system (fig. 4). The hybrid network also should be used with the AN/TRC-3 for short distance single-channel radio communication when Telephone Terminals CF-1-(*) are not available or when weight and size of the equipment are prime considerations (fig. 5).

9. Types of Lines Used

a. Lines and Their Properties. Hybrid Circuit Network TA-255/TT is designed to balance the following types of lines:

(1) 080, 104, or 128 copper-steel lines of 40 percent conductivity, 6- to 12-inch spacing.

(2) 080, 104, 128, or 165 copper wires, 6- to 12-inch spacing. Cable Assemblies CC-358 with connections made by Cable Studs CC-356.

(3) Wire W-143 pairs, nonloaded.

(4) By appropriate adjustment of the network, it is also possible to balance other line facilities. The table below gives the approximate attenuation of the line facilities listed above.

b. Line Construction. Successful operation of a carrier system including hybrid networks requires that the line be of regular construction. If the lines are damaged, poorly spaced, poorly constructed, or have changes in gage or short lengths of inserted cable, the over-all gain will be decreased. Before applying two-

Description	Approx. gage	D-c resistance ohms per loop mile	Approximate attenuation—db per mile									
			Dry					Wet				
			1 kc	8 kc	11 kc	20 kc	30 kc	1 kc	8 kc	11 kc	20 kc	30 kc
080 copper-steel (40%)	14	42.8	.23	.31	.32	.33	.33	.25	.34	.35	.36	.37
104 copper-steel (40%)	12	25.3	.16	.20	.20	.21	.21	.18	.22	.23	.24	.24
128 copper-steel (40%)	10	16.7	.12	.14	.14	.14	.15	.13	.16	.16	.17	.18
080 copper	14	17.5	.11	.13	.14	.16	.19	.13	.15	.17	.20	.24
104 copper	12	10.3	.074	.089	.099	.13	.15	.083	.11	.12	.16	.19
128 copper	10	6.8	.052	.071	.080	.11	.13	.061	.088	.10	.14	.16
165 copper	8	4.1	.034	.056	.064	.084	.10	.042	.072	.083	.11	.13
Cable Assemblies CC-358	—	77	Approx. same as wet					.75	.85	.95	1.5	—
Wire W-143 nonloaded	—	35	Approx. same as wet					1.2	2.1	2.2	2.5	2.9

NOTES:

1. The attenuation figures for open wire are for side circuits at 70° F. and assume 8-inch wire spacing and 200-foot pole spacing except for 080 copper which is 150 feet. They also assume that construction practices outlined in TM 11-368 are followed.

2. The figures for the rubber-covered wire are for 70° F. under wet weather conditions. In dry weather the attenuation will be slightly less.

wire hybrid networks to a line, inspect the line to determine whether its regularity permits adequate operation.

c. Entrance Cable. Lengths of entrance cable or wire located at the end of a repeater section also will affect the amount of balance that can be obtained between the network and the line. The following table lists the maximum lengths of entrance cable that can be balanced with the building-out capacitor in one repeater section:

Type of cable	Entrance cable (ft.)	Cable ½ mi. from one end (ft.)	Cable 4 mi. from one end (ft.)	Cable at middle of repeater section (ft.)
Cable Assemblies CC-368[a]	1,800	600	150	600
W-143 nonloaded	1,200	400	100	400
Paper-insulated cable	3,400	1,200	300	1,100

[a] Or Cable Assemblies CC-358 with connections and loading coils removed. Refer to TM 11-2262 and 11-2263.

d. Intermediate Cable. Lengths of intermediate cable or wire generally cannot be balanced by the hybrid network. Therefore, any length of intermediate cable will decrease the balance which can be obtained. For intermediate cables at locations other than those specified in subparagraph *c* above, estimate the lengths that can be balanced from the figures given. When more than one intermediate cable is encountered in a repeater section, the balance will be reduced further. If cables which are longer than the limiting lengths are used, two-wire operation will be feasible in many cases, but the balance will be degraded and an allowance for this should be made when laying out the repeater sections. Similar considerations also will apply if unstable wire is used.

e. Entrance Cable of Longer Lengths. In some cases it may not be possible to keep the amount of entrance cable down to a length which can be balanced by the network. Also, this entrance cable may be made up of Cable Assemblies CC-358, terminated by Cable Studs CC-356, which cannot be balanced properly as a short entrance cable. In such cases, an additional CF-3-A should be used with the hybrid network as illustrated in *c*, figure 3. For adjustments and line-up of Repeater CF-3-A in this type of hook-up, refer to TM 11-341.

f. Cable Assemblies CC-358. Cable Assemblies CC-358 cannot be used at or near the end of an open wire line because the balance will be very low. The cable can be used near the center of a repeater section, but, in such cases, the balance may be degraded considerably. The 210-foot, loaded, insulated cable section formed from fractional cable assemblies described in TM 11-2262 and TM 11-2263 is designed to have an impedance approximately equal to that of open wire lines. Therefore, one or two such sections at one or more points in an open wire line can be used without materially decreasing the balance. Also, short stretches of insulated wire, twin-pairs using Wire W-143, Wire W-110-B, or Wire W-50, if suspended above the ground and well-separated, can be used at any point in the open wire line.

g. Wire W-143. To use nonloaded Wire W-143, a special equalizer will have to be assembled in the field. Figure 6 is a schematic diagram of such an equalizer. Each equalizer consists of one 80-ohm resistor and two Coils C-114 or C-114-A. The windings of each of the coils are connected in parallel. Then the two coils are connected in parallel and the combination connected in series with an 80-ohm resistor. The special equalizer is connected across the REC binding posts at each terminal. Two such equalizers are required at the repeaters; one equalizer is connected across the AB IN binding posts and a second equalizer is connected across the BA IN binding posts.

10. Selection of Pairs

a. Cross Talk Considerations. When selecting pairs on an open wire line, the controlling consideration will be cross talk. If only one system is to be used on the line, any pair may be used. However, select an outside pair so that another system can be added later. If two systems are to be used on the line, the pairs should be separated as widely as possible. Figure 7 illustrates the location of pairs for the most satisfactory performance. Where good cross talk performance is desired, do not attempt to use more than one system which employs hybrid networks on the same open wire pole line. In some cases, however, this may be done if the net loss of the circuits can be increased to 20 or 30 db or if the upper frequency channels are not used.

b. Operation with Type-C System. Ordinarily, a carrier system using hybrid networks cannot be operated on the same line with a type-C system, or a system using Converters CF-4 and Repeaters CF-5. Operation of hybrid systems in conjunction with their systems is feasible if the pairs are widely separated and the high net losses or very high cross talk can be tol-

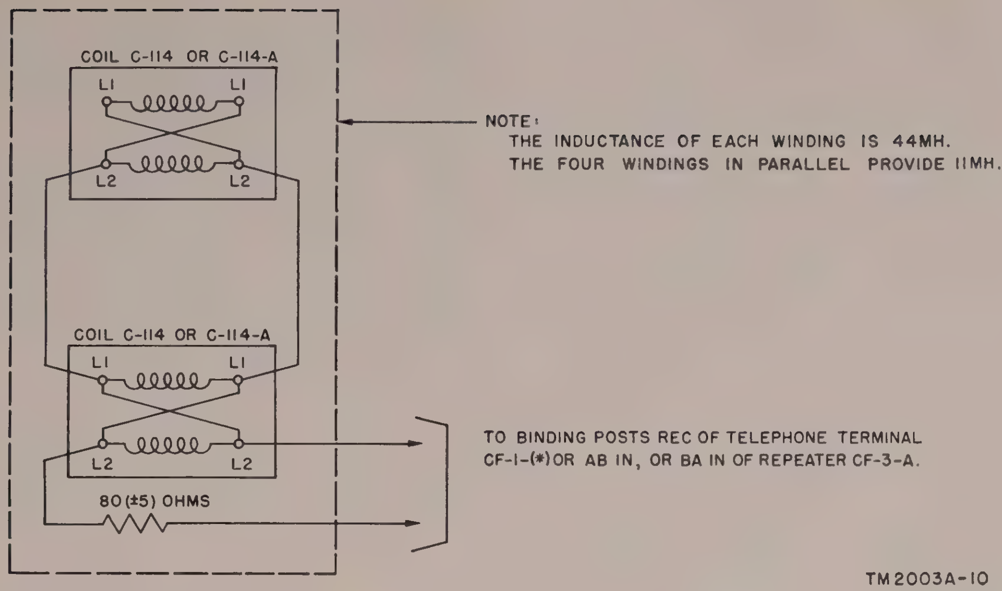

Figure 6. Equalizer for use with nonloaded Wire W-143.

erated, or if the upper frequency channels of the hybrid network system are not used.

c. Operation with V-f (voice-frequency) Circuits. Cross talk ordinarily will not interfere with the operation of a hybrid network system together with v-f circuits, either repeatered or nonrepeatered, on the side circuits of all other pairs on the line. However, excessive cross talk may be experienced between channel 1 of the carrier system and voice-repeatered phantoms.

d. Noise Considerations. Noise usually is not a consideration in the selection of pairs for a system using hybrid networks. However, cross talk from carrier systems using different frequency allocations and beat tones resulting from single frequencies caused by carrier trelegraph systems or carrier leakage to other pairs on the line are potential sources of noise. Noise from such sources will not be serious if the cross talk between the carrier systems is kept low. For high noise levels, or for the purpose of coordinating output power between a carrier system using hybrid networks and other systems on the line, it may be necessary to increase the output power of associated Telephone Terminals CF-1-(*) (TM 11-341 paragraph 11*c*(2)). This will be of advantage where balances are high and noise or cross talk controls the repeater spacing (par. 11).

11. Repeater Spacing Information

a. General. Repeater spacings for a system using hybrid networks are determined by the balance that can be obtained between the line and the network. Before installing a carrier system using hybrid networks, make an estimate of the balances that may be obtained. In making such an estimate, consider the following points:

(1) If the line consists of open wire and is of moderately uniform construction with some entrance cable, but has little or no intermediate cable, few or no bridges, and no definite changes in gage or spacing within a repeater section, it should be possible to obtain and maintain a balance of 25 db.

(2) If the line consists of open wire with changes of gage and spacing and includes intermediate cable, a balance greater than 20 db should not be assumed for layout purposes and, in

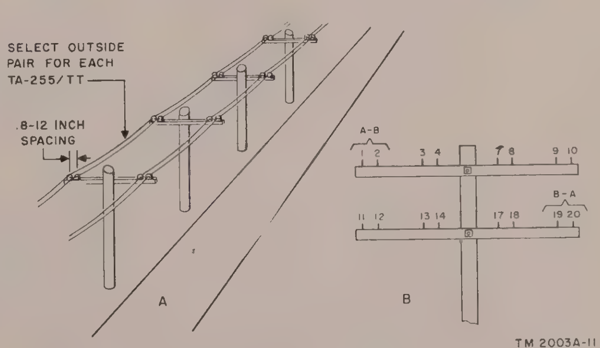

Figure 7. Location of selected pairs on an open wire line.

some cases, even lower balances may be experienced.

(3) If the line is composed of loaded cable, a balance of about 15 db should be obtained.

b. Estimated Repeater Spacing. The estimated maximum repeater spacing for well-constructed open wire lines for various types of balance is given in the following table. The figures given in the table assume that all the repeaters are lined up to have the same output levels. Somewhat longer lengths can be obtained on multirepeatered circuits by *tapering* the output levels. Tapering means using progressively lower repeater output levels proceeding along the circuit from terminal A to terminal B and vice-versa. However, the repeater output levels must not be reduced so far that the circuit becomes noisy. In this arrangement, the intermediate repeater gains are made less than the loss of the preceding line section but more gain is allowable at the circuit terminals. This permits the over-all length of the circuit to be increased.

REPEATER SECTION LENGTHS

Description	6 db net loss					30 db net loss		
	20 db balances			25 db balances			20 db balances	25 db balances
	no rptr	1 rptr	3 rptr	no rptr	1 rptr	3 rptr	no rptr	no rptr
080 copper-steel (40%)	57	43	34	65	57	48	125	134
104 copper-steel (40%)	87	65	52	97	83	70	191	201
128 copper-steel (40%)	125	94	75	135	116	97	275	285
080 copper	118	88	70	131	113	95	259	272
104 copper	167	125	100	185	155	135	367	380
128 copper	200	150	120	210	180	150	440	450
165 copper	241	181	144	246	210	173	530	535

Note. The above figures are for one system on any pair of a four-pair open wire line or for two systems on pairs 1-2 and 9-10 (B, fig. 7). Generally, other combinations will require much shorter repeater sections.

c. Repeater Spacing for Rubber-covered Cable. Estimated maximum repeater spacing for rubber-covered cables is given in the following table. In addition the total system length is given.

Description	6 db net loss						30 db net loss	
	No rptr		1 rptr		3 rptr		No rptr	
	Rptr sect. lg (mi)	System lg (mi)	Rptr sect. lg (mi)	System lg (mi)	Rptr sect. lg (mi)	System lg (mi)	Rptr sect. lg (mi)	System lg (mi)
One pair of Cable Assemblies CC-358	16	16	11	22	7	28	42	42
W-143 nonloaded with special equalizer (par. 9g)	12	12	10	20	9	36	23	23

Section II. SERVICE UPON RECEIPT OF EQUIPMENT

12. Siting

a. External Requirements. Hybrid Circuit Network TA-255/TT has no critical siting requirements. In general, the equipment can be operated in any position under almost all conditions, provided that water is kept out of the case. Usually, the siting of the hybrid network depends on the siting of the equipment with which it is used. However, if the hybrid network is used some distance from the associated equipment, the best location depends on the tactical situation and local conditions, such as the need to install the equipment where it cannot be seen.

b. Wire and Cable Lengths. Whenever possible, locate the hybrid network close to the terminal or re-

peater. If the equipment must be located away from the associated equipment, refer to paragraph 9*c*, for maximum allowable cable and wire lengths.

13. Uncrating, Unpacking, and Checking New Equipment

a. General. Equipment may be shipped in oversea packing cases, in domestic packing cases, or, sometimes, in its own carrying case. Upon receipt of new equipment select a location where the equipment may be unpacked without exposure to the elements and which is convenient to the permanent or semipermanent installation of the equipment.

b. Export Shipment. Figure 8 is a cutaway illustration showing how the equipment is packed for export shipment. To unpack the equipment, proceed as follows:

(1) Cut the metal bands.

(2) Remove the nails with a nail puller from the lid of the packing box. Do not attempt to pry off the lid; the equipment may become damaged.

(3) Remove the lid and the packing material.

(4) Remove the carton from the wooden case.

(5) Remove the unit from the carton and place it on the ground in a clean, dry location.

(6) Open the snap catches and swing open the cover. This exposes the binding posts and operating controls.

(7) Check the contents of the packing case against the master packing slip.

c. Unpacking Domestic Packing Cases. The TA-255 /TT may be received in domestic packing cases. The instructions given above in subparagraph *b* above also

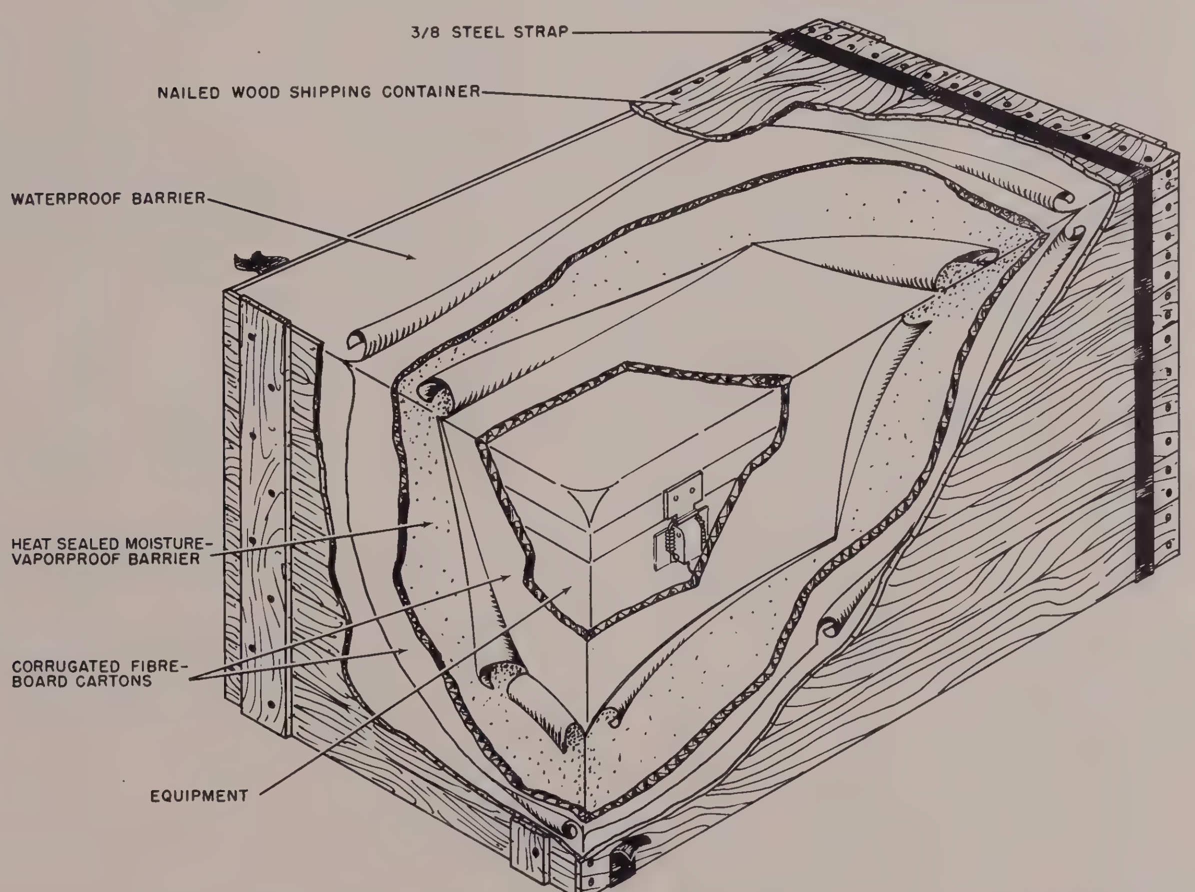

Figure 8. Hybrid Circuit Network TA-255/TT packaged for export shipment, exploded view.

apply to unpacking domestic shipments. To unpack the equipment, proceed as follows:

(1) Cut the metal bands.

(2) Open the cartons that protect the equipment or, if heavy wrapping paper has been used, remove it carefully and take out the equipment.

(3) Check the contents of the packing case against the master packing slip.

Note. Save the original packing-cases and containers for re-use in both export and domestic shipments. They can be used again when the equipment is repacked for storage or shipment.

14. Installation and Grounding

a. Installation of Hybrid Circuit Network TA-255/TT.

(1) Turn the retaining bolts at each corner of the panel to the left. Use a medium size screw driver, well-seated in the fastener slots to avoid burring them. Pull the handles on the panel straight upward until the equipment is completely clear of the case, then set the equipment, top side down, on a clean, flat dry surface.

(2) Inspect the interior of the chassis for loose or broken parts and wiring, or any other damage that may have occurred in shipping.

(3) Check the inside of the case for cleanliness. Re-install the equipment in the case. When the equipment is operated where it will be exposed to the elements, it always is operated with the cover on and fastened down.

(4) Unscrew and remove the six protector blocks. Inspect carefully for broken or cracked porcelain and chipped or pitted carbon; then reinstall.

b. Installation of Ground.

(1) If the hybrid network is being installed near Telephone Terminal CF-1-(*) or Repeater CF-3-A, connect a wire from the GND binding post of the hybrid network to the GND binding post of the adjacent equipment. If the hybrid network is being installed at some distance from the terminal or repeater, a separate ground must be installed.

(2) If a buried water supply piping system is available, it should be used as the common ground.

(3) If a buried water supply piping system is not available, buried gas pipes, underground tanks, or other grounded metallic structures may be used as the ground.

(4) If a grounded metallic structure is not available, Ground Rod MX-148/G must be installed. The installation of the ground rod is described in subparagraphs (*a*) through (*f*) below.

(*a*) Select the lowest, dampest site in the vicinity, preferably in clay or loamy soil.

(*b*) Scoop out a small hole about 6 inches deep in the selected location.

(*c*) Clean any paint or grease from the ground rod.

(*d*) Drive the ground rod into the hole until the top of the rod is approximately 3 inches above the bottom of the hole. When driving the ground rod, strike it just hard enough to cause the rod to penetrate the earth to the desired depth.

(*e*) Connect Clamp TM-106 to the protruding portion of the ground rod.

(*f*) Saturate the ground around the rod with water. Keep the ground moist around the rod by frequent applications of water.

Warning: The ground connection is necessary for operation of the lightning protectors. Failure to provide a good ground connection may result in death or injury to personnel and destruction of the equipment, if the equipment is exposed to high voltages.

15. Connections

a. Connections to Telephone Terminals CF-1-(*) and Repeaters CF-3-A. Connect the binding posts in accordance with the following chart. Figure 9 illustrates the connections in a typical system using hybrid networks.

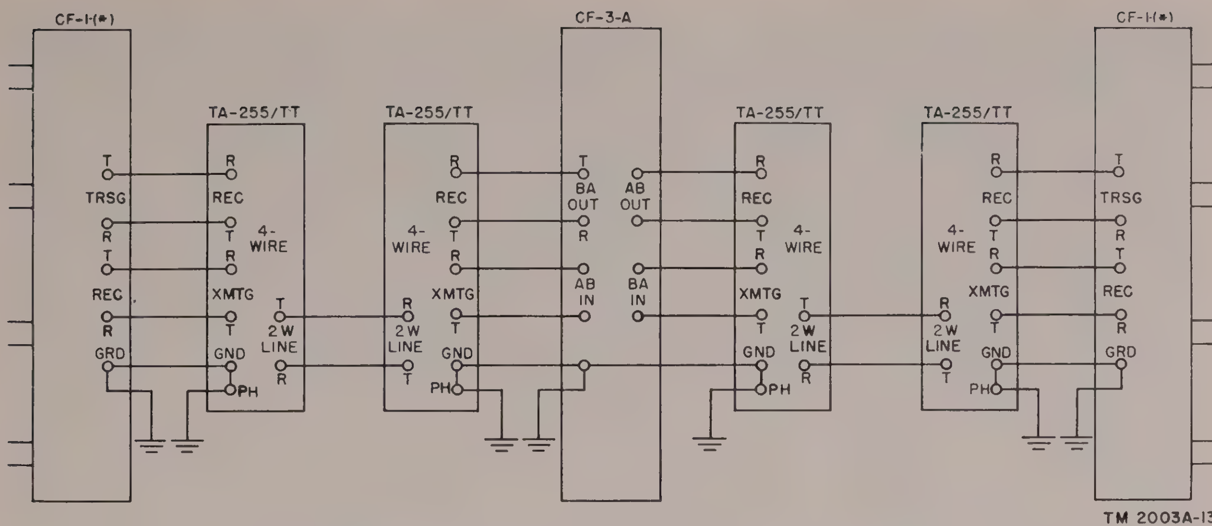

Figure 9. Hybrid Circuit Network TA-255/TT, connected to CF-1-(*) and CF-3-A.

Telephone Terminal CF-1-(*)		Hybrid Circuit Network TA-255/TT
REC	to	XMTG
TRSG	to	REC
GRD	to	GND-PH[a]
Repeater CF-3-A toward terminal A		**Hybrid Circuit Network TA-255/TT**
AB IN	to	XMTG
BA OUT	to	REC
GRD	to	GND-PH[a]
Repeater CF-3-A toward terminal B		**Hybrid Circuit Network TA-255/TT**
BA IN	to	XMTG
AB OUT	to	REC
GRD	to	GND-PH[a]
Hybrid Circuit Network TA-255/TT		**Hybrid Circuit Network TA-255/TT**
T	to	R
R	to	T

[a]GND and PH binding posts are strapped externally. Refer to subparagraph *c* below.

b. Telegraph and Signaling Connections. To bring the telegraph composite set and the telegraph noise filters into the circuit, make connections with 20 gage, or smaller, wire in accordance with the following table:

Location of telegraph or signaling equipment	Connect terminals on TG-SIG CONN terminal strips: At terminal A or at repeater toward terminal B		At terminal B or at repeater toward terminal A	
	REC (Signaling circuit)	XMTG (TG) circuit)	REC (TG circuit)	XMTG (Signaling circuit)
Signaling equipment only at associated CF-1-(*) or CF-3-A	C-D	C-D	C-D	C-D
With telegraph and signaling equipment at associated CF-1-(*) CF-3-A	C-D	A-B-C D-E	A-B-C D-E	C-D
With telegraph and signaling equipment at TA-255/TT	C-D	A-B-C E-F	A-B-C E-F	C-D

Note. If the telegraph equipment is connected to the TA-255/TT, make connections at TG binding posts E6 and E7 and include the telegraph noise filters in the circuit. *The signaling circuit never requires the use of noise filters.*

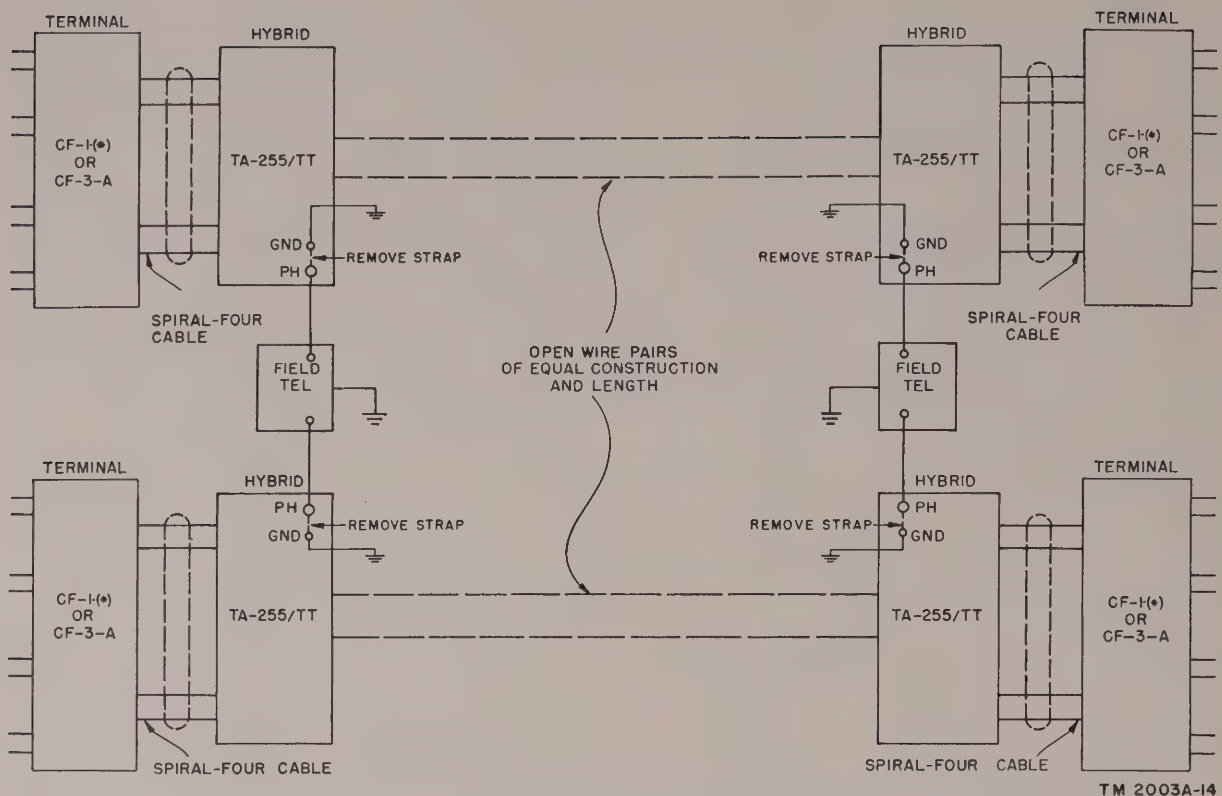

Figure 10. Hybrid Circuit Network TA-255/TT and associated equipment, connections for phantom circuit.

c. Phantom Circuit Connections. To use the phantom circuit, remove the wire strapping GND binding post to PH binding post. Connect a lead from the field telephone to the PH binding post of the TA-255/TT in one system and to the PH binding post of the TA-255/TT in the other system. Establish a low-resistance ground from the field telephone in accordance with paragraph 14*b*. Figure 10 illustrates how the phantom circuit is connected.

d. Connections to Radio Terminal Sets AN/TRC-3. The pair coming from 4W XMTG binding posts, E-15 and E16 of the TA-255/TT, are connected to the transmitter of the associated radio relay sets and the pair from 4W REC binding post, E1 and E2 of the TA-255/TT, are connected to the radio receivers of the associated radio relay sets. Detailed information of the use of a radio relay is contained in TM 11-2601.

16. Service upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraph 13 for uncrating, unpacking, and checking the equipment.

b. Check used or reconditioned equipment for tags or other indications pertaining to changes in the wiring of the equipment. If any changes in wiring have been made, note the change in this instruction book, preferably on the schematic and wiring diagrams.

c. Check the operating controls for ease of operation.

d. Perform the installation and connection procedures given in paragraphs 14 and 15.

Section III. CONTROLS AND INITIAL ADJUSTMENT

Note. This section describes, locates, and illustrates the various controls provided for the proper operation of the equipment; it also furnishes the operator with sufficient information pertaining to these controls.

17. Hybrid Circuit Network TA-255/TT Controls (fig. 11)

The following table lists the controls and functions of the TA-255/TT:

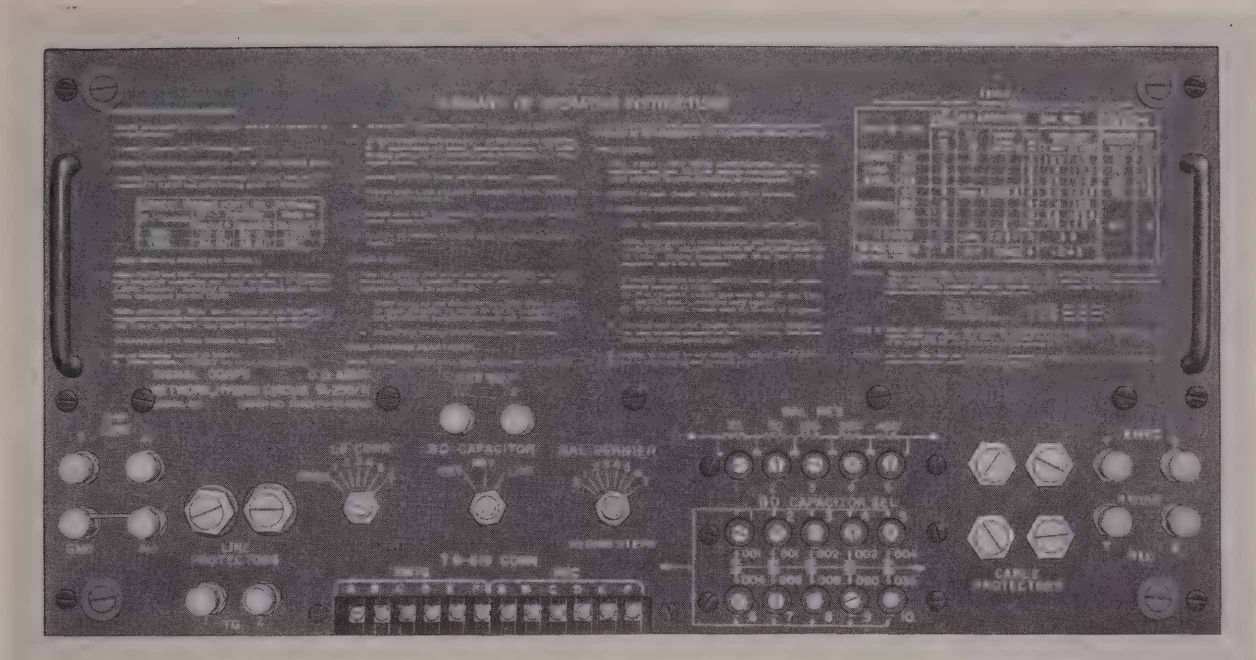

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Figure 11. Hybrid Circuit Network TA-255/TT, front panel.

Control	Function
4 WIRE, binding posts (E1, E2, E15, E16)	Compression-type binding posts for connecting hybrid network to four-wire line.
2-W LINE binding posts (E8, E9)	Compression-type binding posts for connections to two-wire line.
GND, binding post (E18)	Compression-type binding post for connections to ground.
PH, binding post (E17)	Compression-type binding post for connection to field telephone when using phantom circuit. Normally this binding post will remain strapped to GND binding post, E18, by use of a piece of heavy gage wire.
TG 1 and 2, binding posts (E6, E7)	Compression-type binding posts for connections to telegraph repeater sets.
EXT NET 1 and 2, binding posts (E5, E12)	Compression-type binding posts for connecting an external network to the balancing network contained in TA-255/TT.
TG-SIG CONN (TB1)	12-position terminal board, divided into two sections, XMTG and REC. Terminals of each section are lettered from A through F. Used for making telegraph and signaling connections. By strapping terminals B-C-D together, telegraph composite set is brought into circuit. Terminals A and E are for bringing telegraph noise filters into circuit. Terminal F is connected permanently to TG binding posts, E6 and E7, to make it possible to connect telegraph repeaters directly to the telegraph composite set in TA-255/TT.
LF CORR switch (S2)	Eight-position rotary switch with an open position at both ends. Operated with screw driver. Seven-numbered positions on switch are for bringing various resistors and capacitors in balancing network into circuit. By turning switch from step 1 toward step 6, resistance and capacitive reactance are progressively decreased at low frequencies.

Control	Function
BO CAPACITOR switch (S3)	Three-position rotary switch. Operated with screw driver. Used to connect the building-out capacitor unit in parallel with other components of balancing network or in parallel with two-wire line. Open position on switch is provided for disconnecting building-out capacitor entirely from circuit.
BAL VERNIER switch (S1)	Eight-position rotary switch. Operated with screw driver. Connected to seven 10-ohm resistors. By turning dial from step 1 toward step 7, these resistors can be brought progressively into balancing network.
BO CAPACITOR SEL screw-down switches (S5, S6)	Terminal board-type switches with individual screw-down type contacts. Leads from switch contacts are brought out to terminals on building-out capacitor unit. Desired capacitance is obtained by adjusting contact screws. Capacitance of each unit is marked on panel.
BAL RES screw-down switch (S4)	Terminal board-type switch with individual screw-down type contacts. Leads from switch contacts are connected to five resistors. By manipulating contact screws properly, several resistance values from 0 to 775 ohms may be obtained. It is part of balancing network.

18. Adjustment of Balancing Network

a. Repeater spacing (par. 11) for the two-wire carrier system is determined by the balance which can be obtained between the line and the balancing networks contained in the hybrid networks. If the line consists of open wire and is uniform in construction with some entrance cable, but has little or no intermediate cable, few or no bridges, and no definite changes in gage or spacing within a repeater section, it should be possible to obtain and maintain a balance of 25 db. If the line consists of open wire with changes in gage and spacing and includes intermediate cable, a balance greater than 20 db cannot be assumed. If the line is composed of loaded cable, a balance of about 15 db should be obtained.

b. The following table lists the switch adjustments for the various types of lines:

		LF CORR	BO CAPACITOR		BAL VERNIER	BAL RES	
Type of circuit	Spacing open wire only (in.)	Set switch to	Set switch to	Screw-down contacts	Set switch to	Screw-down contacts	Total res (ohms)
080 copper-steel (40%)	8	1	OUT	None	3	1, 2, 3	630
	12	1	OUT	None	3	1, 3	680
104 copper-steel	8	2	OUT	None	3	1, 4	580
	12	2	OUT	None	4	1, 2, 3	640
128 copper-steel (40%)	8	3	OUT	None	3	3, 5	305
	12	3	OUT	None	4	1, 2, 3	355
080 copper	8	3	OUT	None	4	2, 5	365
	12	3	OUT	None	3	1, 2, 3, 4	430
104 copper	8	4	OUT	None	4	1, 4	590
	12	4	OUT	None	4	1, 2, 3	640
128 copper	8	5	OUT	None	4	2, 5	365
	12	5	OUT	None	3	1, 2, 3, 4	430
165 copper	8	5	OUT	None	3	1, 2, 5	330
	12	5	OUT	None	4	1, 5	390

Type of circuit	Spacing open wire only (in.)	LF CORR Set switch to	BO CAPACITOR Set switch to	BO CAPACITOR Screw-down contacts	BAL VERNIER Set switch to	BAL RES Screw-down contacts	BAL RES Total res (ohms)
CC-358 full coil terminals		5	LINE	1, 3, 5, 7	3	3, 5	305
W-143 nonloaded with special equalization		4	OUT	None	3	3	80
W-143 1650-6 mid section terminal		6	OUT	None	4	1, 2, 4, 5	140
Circuit requiring external network		OPEN	OUT	None	0	None	0

Note. The BO CAPACITOR adjustment shown for open wire circuits apply when entrance cable is not used. When entrance cable or wire is used, refer to subparagraph *c* below to supplement the information in the table above.

c. If entrance cable or wire is used between the hybrid network and the open wire line, operate BO CAPACITOR switch S3 to NET position and screw down the proper contacts on BO CAPACITOR SEL contact switches S5 and S6 to obtain a total capacitance equal to the capacitance of the entrance cable or wire.

(1) Cable and wire capacitance can be obtained from the following table:

Type of cable	Capacitance per 100 ft. in μf
Wire W-143	.0033
Cable Assemblies CC-368 or CC-358 with connectors and loading coils removed	.0022
Paper-insulated, lead-covered cable	.0012

(2) As an example of the adjustment of the BO CAPACITOR, assume that there is an entrance cable consisting of 275 feet of nonloaded wire W-143. The required building out capacitance would be $2.75 \times .0033 = .009075$ μf (microfarad). Approximately this value of building-out capacitance would be obtained by screwing down the contact posts marked 1 and 7 on BO CAPACITOR SEL contact switches S5 and S6.

d. If the facility is not known or is not covered in subparagraph *c* above, adjust the balancing network initially as follows:

	LF CORR switch setting	BO CAPACITOR switch setting	Set BAL VERNIER switch to	BAL RES screw-down contacts	TOTAL res. ohms
Open wire	3	OUT	0	1, 2, 3	600
Nonloaded cable or field wire	5	OUT	0	1, 2, 4, 5	100

19. Preliminary Settings of Dials at Telephone Terminals CF-1-(*) and Repeaters CF-3-A

The table below lists the settings of the dials at the terminals and repeaters in a system using hybrid networks.

Facility	Length of preceding repeater section (mi)	Setting of dials on CF-1-(*) and CF-3-A panels: MILES dial	Dial 1	Dial 4	Dial 2
080 copper-steel (40%)	20-30	0	19	4	5
	30-40	0	22	5	6
	40-50	5	27	6	6
	50-60	15	29	7	7
	60-70	20	30	8	7
	70-80	25	30	9	8
	Over 80	30	30	10	8
104 copper-steel (40%)	30-40	0	20	4	5
	40-50	0	22	4	5
	50-60	5	25	4	6
	60-70	10	27	4	6
	70-80	15	29	5	6
	80-90	20	30	5	6
	90-100	25	30	6	7
	Over 100	30	30	6	7

Facility	Length of preceding repeater section (mi)	Setting of dials on CF-1-(*) and CF-3-A panels			
		MILES dial	Dial 1	Dial 4	Dial 2
128 copper-steel (40%)	50-70	0	22	4	5
	70-90	5	26	4	5
	90-110	10	29	5	5
	110-130	15	30	5	6
	130-150	20	30	6	6
	150-170	25	30	6	7
	Over 170	30	30	7	7
080 copper	60-80	0	22	5	5
	80-100	0	25	6	5
	100-120	0	28	6	5
	120-140	5	30	7	5
	140-160	10	30	7	5
	160-180	15	30	8	5
	Over 180	20	30	9	5
104 copper	50-100	0	21	4	4
	100-150	0	24	6	4
	150-200	0	27	7	5
	200-250	5	30	9	5
	250-300	10	30	10	5
	Over 300	15	30	12	5
128 copper	50-100	0	19	4	4
	100-150	0	21	6	4
	150-200	0	23	8	5
	200-250	0	26	10	5
	250-300	0	28	12	5
	Over 300	0	30	14	5

Facility	Length of preceding repeater section (mi)	Setting of dials on CF-1-(*) and CF-3-A panels			
		MILES dial	Dial 1	Dial 4	Dial 2
165 copper	100-150	0	18	6	5
	150-200	0	20	8	5
	200-250	0	22	10	5
	250-300	0	24	12	5
	300-350	0	27	14	5
	Over 350	0	30	14	5
Cable assemblies CC-358	10	0	21	3	4
	15	0	27	3	4
	20	5	30	5	5
	30	15	30	6	5
	40	25	30	8	5
Wire W-143 nonloaded with special equalization[a]	6	30	20	4	4
	8	30	25	6	5
	10	30	30	8	6
	12	30	30	10	7
	14	30	30	12	8
	16	30	30	13	8
	18	30	30	14	8

[a]Refer to paragraph 9*g*.

Section IV. SYSTEM LINE-UP PROCEDURES

20. Temporary Communications for Line-up

a. When the hybrid network is located at some distance from its associated terminals or repeaters, the final network adjustments must be made by two men; one working at each equipment unit. In this case, communication between the men can be accomplished with the use of Telephone Unit EE-105 connected across each end of one of the circuits which connects the hybrid network to its associated equipment.

b. If available, Telephones EE-8A can be used over a separate wire or cable service. Telephones EE-8A also can be used on one of the circuits connecting the hybrid network to its associated terminals or repeaters by using the ground and simplex of one of the d-c telegraph circuits. Connections for such an order circuit are shown in the following table:

Location of TA-255/TT	Connect terminals D and F on TG-SIG CONN strip (TA-255/TT)	Connect Telephone EE-8A at TA-255/TT to GND binding post and to binding post:	Connect Telephone EE-8A at CF-1(*) or CF-3-A to GRD binding post and to binding post:
Terminal A	TR	TG-1	SX REC
Repeater towards A	REC	TG-2	SX BA OUT
Repeater towards B	TR	TG-1	SX BA IN
Terminal B	REC	TG-2	SX TRSG

21. Initial System Line-up

a. Line up the system and adjust the net loss of the channels in each direction in accordance with the standard procedure for Telephone Terminals CF-1(*) and Repeaters CF-3-A as described in TM 11-341, except as outlined in subparagraph *b* below.

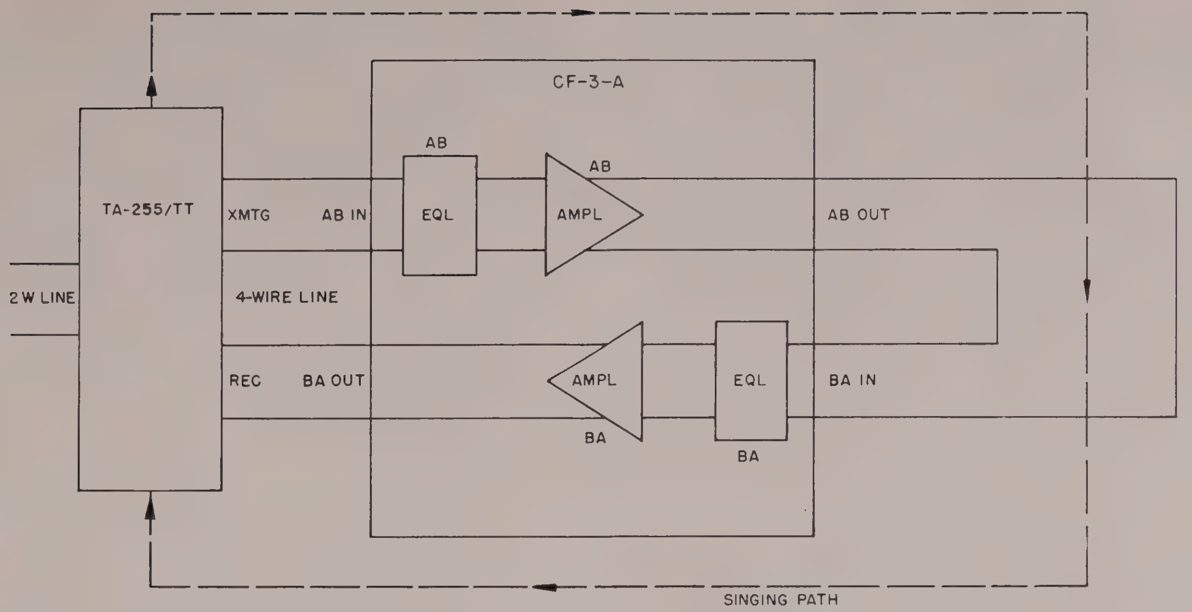


Figure 12. Connections for 21 test, block diagram.

b. Make additional dial settings at terminals and repeaters as follows:

(1) Set all dials at the terminals and repeaters in accordance with the table in paragraph 20. Set the dial in accordance with the direction being lined up.

(2) When lining up in the AB direction, operate dials 1 and 4 of the BA direction to steps 18 and 0, respectively, at all terminals and repeaters.

Note. These settings for the BA direction are specified to hold down the BA repeater gain so that singing will not occur in the line-up at this point.

(3) When lining up in the BA direction, operate dials 1 and 4 of the AB directions to steps 18 and 0, respectively, at all terminals and repeaters to prevent singing.

(4) Check for singing at the terminals by monitoring each channel in turn. If singing is heard, check all dials and switches to be sure they have been set properly. If singing persists, proceed as described in subparagraph (5) below.

(5) Check for singing at the repeaters by pressing the MEAS key and observing the meter for each position of the MEAS switch. A large off-scale deflection of the meter will indicate singing. If the meter indicates singing, reduce the setting of the AB or BA EQL dials at the repeaters and proceed with the line-up.

(6) Record all dial settings immediately after the initial line-up in each direction.

22. Final Network Adjustments for Terminals and Repeaters

a. The impedance of all the balancing networks in the system must be approximately equal to that of the line at all frequencies in the transmitted band. If the networks of each piece of equipment in the system are not balanced properly, there may be singing at those frequencies where impedance mismatch exists.

b. Before the final adjustments can be made for the networks of the terminals and repeaters using hybrid networks, it is necessary to understand the functions of the 21 test (par. 23) and the 22 test (par. 24), for the measurement of balance.

23. 21 Test (fig. 12)

a. 21 Test at Repeaters. The 21 test is performed individually at each repeater and its adjacent hybrid network. The test is made first in the A direction and again in the B direction. Figure 12 is a simplified block

diagram of the 21 test. The progressive steps for the 21 test at repeaters are as follows:

(1) Record all dial settings at the adjacent terminals or repeater. Turn all EQL dials to 0 position. Record all dial settings at the repeater under test.

(2) On AB EQL panel of the repeater under test, turn dial 1 to 0 and other dials to settings determined in the initial line-up (par. 21).

(3) On BA EQL panel, turn MILES dial to 0, dial 1 to 20, dial 2 to 4, and dial 4 to 2.

(4) Disconnect the wires from binding posts BA IN and AB OUT and connect BA IN to AB OUT as shown in figure 12.

(5) Turn the switch on the MEAS panel to 4 and hold MEAS key lever on AB. Adjust EQL AB dial 1, and EQL BA dial 1, until singing just occurs as indicated by deflection of the meter. Release MEAS key lever *immediately* so that the meter will not be injured, and note the sum of EQL AB and EQL BA dial 1 settings. Repeat with the switch on MEAS panel turned to 3, 2 and 1, in turn. Record the lowest sum of EQL AB and EQL BA dial 1 settings found for any of the four switch positions.

(6) Reverse the wires connected to AB IN binding posts to reverse poling and then repeat the procedure described in subparagraph (5) above.

(7) The lowest sum of dial 1 settings recorded in subparagraphs (5) and (6) above indicates balance and should be made as high as possible in the final network adjustments.

(8) *Balance in db is sum of dial 1 settings in paragraph (7) above plus sum of dial 4 settings minus 23.*

(9) Restore all connections and dials to normal.

b. 21 Test at Terminals. The 21 test is performed at each terminal and its adjacent hybrid network in the following manner:

(1) At the adjacent terminal or repeater, record all dial settings and turn all EQL dials to 0. Record all dial settings at the terminal under test.

(2) Disconnect the four T leads to 2W binding posts CH1, CH2, CH3, and CH4 at the terminal. Operate OUTPUT key lever, if provided, to NORMAL and REC LEV (or LEV) key downward. Leave all EQL dials on normal setting and turn GAIN dials to 30 on all channels.

(3) On CHAN 4 panel, throw TALK-MON to MON and monitor. Adjust EQL dial 1 until singing starts and note EQL dial 1 setting. Repeat on channels 3, 2, and 1 in turn. Record the lowest setting of EQL dial 1 found for any of the four channels.

(4) Reverse the wires connected to REC binding posts to reverse poling and then repeat the procedure described in subparagraph (3) above.

(5 The lowest setting of EQL dial 1 obtained in subparagraphs (3) and (4) above indicates balance and should be made as high as possible in the final network adjustment.

(6) *The approximate balance in db is equal to EQL dial 1 setting (subpar. (5) above) plus EQL dial 4 setting minus 4.*

(7) Restore all connections and dials to normal.

Note. When only one man is available at a terminal for making network adjustments, it generally will be easier to observe singing (subpar. (3) above) by operating the TALK-MON key to TALK (a locking position of the key) rather than to MON. In following this procedure, do not operate on more than one channel at a time. After the best apparent adjustment has been made in this manner, check and make the balance measurements with the TALK-MON key in the MON position.

24. 22 Test (fig. 13)

a. After operating adjustments for the equipment have been made, the singing margin for terminals and repeaters with their associated hybrid networks, can be determined by means of the 22 test. Figure 13 is a simplified block diagram showing the test on a typical system. Both equalizers are operated to their normal settings and connections on each side of the equipment are left normal so that the singing path includes the loss across both hybrid networks. In addition, the gains of all other repeaters on the circuit are made normal so as to include the additional singing paths formed through the network hybrids on the far side of those repeaters.

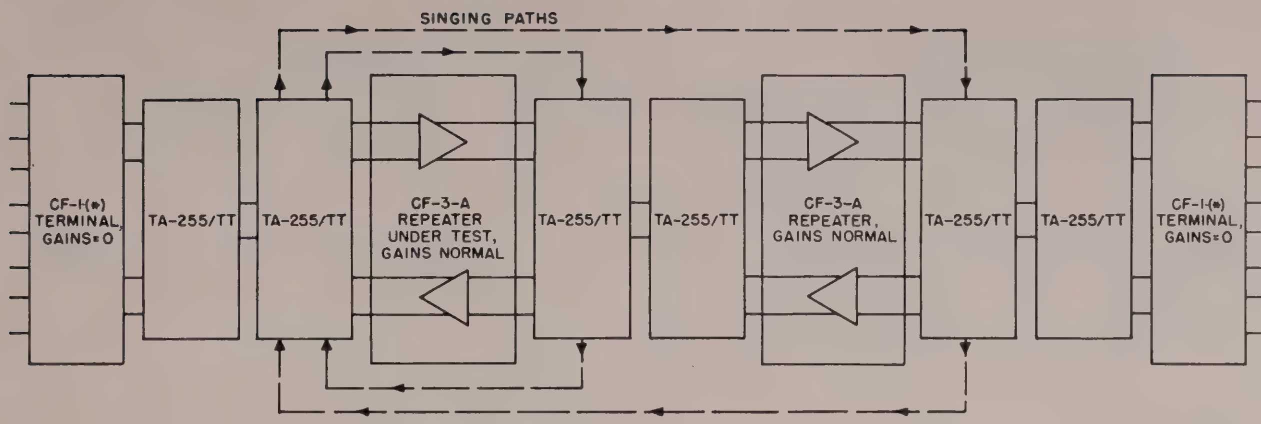


Figure 13. Connections for 22 test, block diagram.

b. A 22 test differs from a 21 test in that a 22 test depends on the change in gain from normal gain to the gain required to produce singing. A 21 test depends only on the absolute value of the gain required to cause singing.

c. The 22 test is performed at each repeater in the following manner:

(1) At both associated terminals turn all EQL dials to 0. Leave EQL dials in normal positions at other repeaters.

(2) At the repeater under test, operate the switch on MEAS panel to 4 and hold MEAS key lever on B. With other EQL dials normal, adjust EQL AB dial 1, and EQL BA dial 1, until singing just starts as indicated by the deflection of the meter. Release MEAS key lever *immediately* to prevent damage to the meter and note the sum of EQL AB and EQL BA dial 1 settings. Repeat with the switch on MEAS panel turned to 3, 2, and 1 in turn. Record the lowest sum of EQL AB BA dial 1 settings found for any of the four switch positions.

(3) *The singing margin for the repeater is equal to the lowest sum determined in subparagraph (2) above, minus the sum of dial 1 normal settings.*

(4) Restore all keys and dials to normal.

d. When one terminal is under test, the gains at both terminals are reduced to a minimum since it is not desirable to include the singing paths through these equipments when making the test. The 22 test determines the change in the terminal gains from their normal gains to those gains necessary to cause singing margin. The 22 test is performed at the terminals in the following manner:

(1) At the far terminal, turn all EQL dials to 0. At repeaters, leave dials in normal position.

(2) At terminal under test, operate REC LEV (or LEV) key lever downward. Leave EQL dials on normal settings. Leave connections to all CH binding posts T and R normal.

(3) On Channel 4 panel, operate TALK-MON key to MON and monitor. Adjust GAIN dial on channel 4 panel until singing just occurs.

(4) *Singing margin for channel 4 is equal to 10 plus the setting of GAIN dial on channel 4 (when singing just starts) minus the normal setting of GAIN dial on channel 4.*

(5) Restore GAIN dial to normal.

(6) Repeat the instruction in subparagraph (3) above for channels 3, 2, and 1 in turn to obtain the singing margin on those channels.

(7) Restore all keys and dials to normal.

25. Final Adjustment of TA-255/TT Balancing Networks

After the initial system line-up, make final balancing network adjustments at the hybrid networks to obtain as high a balance as possible at each point. Starting with the first hybrid network at either terminal, measure the balance in accordance with paragraphs 23 and 24. Then follow the procedure in the following table.

Item	Action	Condition
1. BAL RES and BAL VERNIER	Turn BAL VERNIER switch S1 clockwise one step and measure balance.	If the balance increases or remains unchanged, continue to turn the BAL VERNIER switch, and measure the balance on each step until a maximum balance is obtained.
		If the balance decreases, turn BAL VERNIER switch towards step 0 one step at a time until a maximum balance is reached.
		If the balance cannot be reached by turning the BAL VERNIER switch toward 0, adjust the contact screws on the BAL RES contact switch so as to remove 50 ohms. Set BAL VERNIER rotary switch on step 5 and continue to turn towards step 0 as required.
		If the BAL VERNIER switch reaches step 7 in the steps above, adjust the contact screws on the BAL RES contact switch so as to add 50 ohms. Turn the BAL VERNIER switch to step 2 and continue to turn towards step 7 as required.
2. BO CAPACITOR Switch.	If the preliminary position of BO CAPACITOR switch is OUT, turn the switch to NET and adjust the screws on the BO CAPACITOR SEL switches for .001 μf.	If balance increases or remains unchanged, continue to increase capacitance with the BO CAPACITOR SEL switches one step at a time, until a maximum balance is obtained.
	If the preliminary adjustment of the BO CAPACITOR switch is LINE, change the specified setting of the BO CAPACITOR SEL switches to increase the specified amount of capacitance by .001 μf.	If the balance has increased or remains unchanged, continue to increase capacitance with the BO CAPACITOR SEL contact switches until a maximum balance is obtained.
		If the balance has decreased, reduce the capacitance with the BO CAPACITOR SEL contact switches until a maximum balance is obtained.
		If the BO CAPACITOR SEL is adjusted to 0 and maximum balance is obtained, turn the BO CAPACITOR switch to NET and repeat the procedure above.
	If the preliminary adjustment of the BO CAPACITOR switch is NET, change the setting of the BO CAPACITOR SEL switches to increase the specified capacitance by .001 μf.	If the balance increases or remains the same, continue to increase the capacitance with the BO CAPACITOR SEL switches until a maximum balance is obtained.

Item	Action	Condition
		If the balance decreases, reduce the capacitance with the BO CAPACITOR SEL switches until a maximum balance is obtained. If the maximum balance is not reached, and BO CAPACITOR SEL switch has been adjusted to 0 microfarads, turn the BO CAPACITOR switch to LINE and repeat the procedure outlined above for the NET setting.
3. BAL RES and BAL VERNIER	After the best possible adjustment of the BO CAPACITOR SEL switch has been obtained, repeat adjustment procedure for BAL RES and BAL VERNIER described in item 1 of this chart.	
4. L F CORR	In some cases it may be desirable to try other settings of the LF CORR switch and to repeat Item 1 and 2 of this table. Use a cut-and-try process until the best combination of the BAL RES, BAL VERNIER and BO CAPACITOR SEL switches are determined.	

26. Final System Lineup Procedures

After the final network adjustments are made, make the final system line-up in accordance with the following table. Follow the steps in numerical sequence.

Step	Action	Conditions
1.	Turn all equalizer and gain dials to the settings determined by the initial line-up for both directions of transmission and monitor on each channel in turn at each terminal.	If singing is heard, make singing margin test in accordance with paragraphs 23 and 24. If singing is not heard on any channel, proceed with step 2 of this table.
2.	Line up the system in the standard manner for terminal and repeater equipment. Make singing margin tests in accordance with paragraphs 23 and 24.	If the singing margin is not at least 10 db at a repeater, reduce the gain with dial 1 by equal amounts in both directions of transmission to obtain 10-db singing margin. If the singing margin is not at least 6 db at a terminal, reduce the gain with the GAIN dials of each channel to obtain 6-db singing margin on each channel.
3.	Measure the net loss of channel 4 in both directions. Adjust the proper GAIN dial to obtain a net loss in each direction equal to the larger of the two values measured.	If singing is heard on any channel, reduce the gain in each direction at all repeaters and the receiving gain at both terminals 2 db, by turning dial 1 counterclockwise on each EQL panel two steps. If the singing does not stop, reduce the dial 1 setting at each repeater and terminal an additional step at each point. Continue to reduce dial 1 setting until singing stops. Record all dial settings at all locations.
4.	Make singing margin tests at each point as described in paragraphs 23 and 24.	If the singing margin is not at least 10 db at a repeater and 6 db at a terminal, repeat step 2 of this table. If the singing margin is greater than 10 db at a repeater and 6 db at a terminal, the repeater gains may be increased, but not above the gains determined in the initial lineup.

Note. In case it is desired to improve the system line-up by the use of more precise line-up methods, refer to paragraph 27.

27. Special Line-up Procedures

a. When personnel skilled in the operation of two-wire circuits are available, the procedure described in paragraphs 21 through 26 can be modified to obtain improved performance. Usually, improvements in performance will be made after a system has been placed in operation and there is time to make more refined adjustments of gain and equalization.

b. When the singing margin is insufficient at the gains of the initial lineup (Par. 21), the gains at the critical points may be reduced by reducing the setting of EQL dial 1. This dial produces an equal gain change at all frequencies and affects all channels alike. Singing is most likely to occur on the highest frequency channel. When singing occurs at a high frequency, the singing margins still are usually adequate on lower frequency channels. In such cases, the reduction of gain by reducing the setting of EQL dial 1 penalizes the channels with adequate singing margin. A better, though more complicated, procedure would be to reduce the gain at the high frequencies more than at the low frequencies. The net effect of this procedure, when used under conditions which warrant it, is to permit considerably lower net losses on some channels than would be obtained otherwise.

c. Control of the singing margin by means of dial 4 alone sometimes will cause the singing frequency to shift from one channel to another. Generally, best results will require the manipulation of dials 1, 2, and 4 so as to obtain the highest practicable gain with adequate singing margin over each channel. More specific instructions for such adjustments cannot be given. However, it will be found that a considerable improvement in system performance can be obtained by this means when there is difficulty with low singing margins. When testing a repeater or terminal, the singing frequency can be determined by having an attendant monitor the various channels at one of the terminals. Knowledge of the approximate value of the singing frequency (channel number) is useful as a guide in adjustments of this kind.

28. Operation and Maintenance of the System

a. After a system has been lined up, it still will be necessary to make daily measurements and periodic line-ups. The procedures for these tests are given in section II of TM 11-341.

b. General procedures for system maintenance are given in section IV of TM 11-341. In the case of two-wire circuits, however, line changes due to weather and temperature may result in decreases in singing margins. These changes, in turn, may cause hollowness or singing. If any channel becomes hollow or sings, follow the procedure outlined in paragraph 25. In cases of complete failure due to singing, balance measurements (21 test, paragraph 23) may be of assistance in determining the repeater section in which trouble is located. Low balances usually will indicate line trouble on the side of the repeater or adjacent to the terminal where the low balance is observed.

Section V. OPERATION UNDER USUAL CONDITIONS

29. Starting Procedure

To set Hybrid Circuit Network TA-255/TT into operation, make connections for the desired type of operation, as described in paragraph 15. Then operate the controls and switches to the positions indicated in paragraph 18.

30. Stopping Procedure

Upon receiving instructions from the control station, take Hybrid Circuit Networks TA-255/TT out of operation by disconnecting all wires from the binding posts. Replace the cover on the case and fasten down the cover.

Section VI. OPERATION UNDER UNUSUAL CONDITIONS

31. General

It may be necessary to operate Hybrid Circuit Network TA-255/TT in regions where extreme cold, heat, humidity, moisture, sand conditions, etc., prevail. Paragraphs 32 through 34 contain instructions for minimizing the effects of these unusual operating conditions.

32. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of the TA-255/TT. The following are instructions and precautions for operation under such adverse conditions:

a. Keep the equipment covered and dry. Always fasten down the cover after making connections and adjustments.

b. When equipment which has been exposed to the cold is brought into a warm room, the equipment will sweat until it reaches room temperature. When the hybrid network has reached room temperature, dry it thoroughly. Sweating also may arise when equipment warms up during the day after exposure during a cold night.

33. Operation in Tropical Climates

When operated in tropical climates, the hybrid network may be installed in tents, huts, or, when necessary, in underground dugouts. When equipment is installed below ground level, or when it is set up in swampy areas, moisture conditions are more acute than normal. Ventilation is very poor, and the high relative humidity causes condensation of moisture on the equipment whenever the temperature becomes lower than that of the ambient air. To minimize this condition, keep the network hybrid carrying case cover fastened down and covered with a tarpaulin or any available cover.

34. Operation in Desert Climates

a. Conditions similar to those in tropical climates often prevail in desert areas. Use the same measures described in paragraph 33 to insure proper operation of the hybrid network.

b. The main problem which arises with operations in desert areas is from the large amount of sand and dust which enter the equipment. Though the hybrid network is mounted in a dustproof case, be careful to place the equipment in as dust-free a location as possible.

c. Never tie wiring connections to the inside or outside of tents. Desert areas are subject to sudden wind squalls which may jerk connections loose or break the lines.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. PREVENTIVE MAINTENANCE SERVICES

35. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent the occurrence of troubles rather than to repair troubles. See AR 750-5.

36. General Preventive Maintenance Techniques

a. Use #0000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with Solvent, Dry Cleaning (SD); then wipe the parts dry with a cloth.

(2) Clean electrical contacts by flushing with carbon tetrachloride (subpar. *d* below).

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Make sure adequate ventilation is provided.

c. If available, dry, compressed air may be used at line pressure not exceeding 60 psi (pounds per square inch) to remove dust from inaccessible places; be careful, however, or mechanical damage from the air blast may result.

d. Gasoline will not be used as a cleaning fluid for any purpose. Carbon tetrachloride will be used as a cleaning fluid only on switch contacts and electrical equipment on which inflammable solvents cannot be used because of fire hazard.

e. For further information on preventive maintenance techniques, refer to TB SIG 123.

Note. No lubrication is necessary for the TA-255/TT.

37. Use of Preventive Maintenance Forms (figs. 14 and 15)

a. The decision as to which items on DA AGO Forms 11-238 and 11-239 are applicable to this equipment is a tactical decision to be made in the case of first echelon maintenance by the communication officer/chief or his designated representative, and in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

b. Circled items in figures 14 and 15 are partially or totally applicable to Hybrid Circuit Network TA-255/TT. References in the ITEM block refer to paragraphs in text which contain additional maintenance information.

Section II. WEATHERPROOFING

38. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growths, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised, which, if properly applied, provides a reasonable degree of protection. This treatment is explained fully in TB SIG 72.

c. Winter Maintenance. Special precautions necessary to prevent poor performance or total operational

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.
NETWORK, HYBRID CIRCUIT TA-255/TT	

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.

NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (*receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories*). PAR.14							
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR.12,14							
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR.14,36b,39							
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS.							
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 41							
6	CHECK FOR NORMAL OPERATION. PAR.43							

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR.14,41		13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR.14,39		14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR.14		15	INSPECT METERS FOR DAMAGED GLASS AND CASES.	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.		16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING. PAR.12,14	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING. PAR.14,41		17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR.14,41		18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	

19 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA AGO FORM 1 MAY 51 11-238 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM 2003A-49

Figure 14. DA AGO Form 11-238.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.
NETWORK, HYBRID CIRCUIT TA-255/TT	

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT *(receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories).* PAR.14		19	ELECTRON TUBES - INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS; INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES.	
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR.12,14		20	INSPECT FILM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.	
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR.14,36b,39		21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR.41	
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS.		22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS.	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR.41		23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS.	
6	CHECK FOR NORMAL OPERATION. PAR.43		24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR.41	
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR.14,41		25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS. PAR.14,41	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR.14,39		26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR.14	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR.14		27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS. PAR.14	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.		28	CHECK SETTINGS OF ADJUSTABLE RELAYS.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING. PAR.14,41		29	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER.	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR.14,41		30	INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.	
13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.		31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS. PAR.14,41	
14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.		32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE. PAR.14,41	
15	INSPECT METERS FOR DAMAGED GLASS AND CASES.		33	BEFORE SHIPPING OR STORING - REMOVE BATTERIES.	
16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING. PAR.12,14		34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.	
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.		35	INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.	
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.		36	PAR.14 INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.	
			37	MOISTURE AND FUNGIPROOF. PAR.38	
38	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.				

DA AGO FORM 1 MAY 51 11-239 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM 2003A-50

Figure 15. DA AGO Form 11-239

failure of equipment in extremely low temperatures are explained fully in TB SIG 66.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to low humidity and excessive sand and dust are explained fully in TB SIG 75.

39. Rustproofing and Painting

a. If the finish on the panel is badly damaged, rust and corrosion can be prevented by touching up bared surfaces. Use #000 or #0000 sandpaper to clean the surface down to the bare metal until a bright, smooth finish is obtained.

Caution: Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touch-up job is necessary, apply paint with a small brush. Remove rust from the unit by cleaning the corroded metal with solvent (SD). In severe cases it may be necessary to use sandpaper to complete the preparation for painting. Paint used will be authorized in accordance with existing regulations.

Section III. TROUBLE SHOOTING AT ORGANIZATIONAL MAINTENANCE LEVELS

40. General

a. The trouble shooting and repair work that can be performed at the organizational maintenance level (operators and repairmen) is limited necessarily in scope by the tools, test equipment, and replaceable parts issued, and by the existing tactical situation. Accordingly, trouble shooting is based on the performance of the equipment and the use of the senses in determining troubles such as broken wires and cracked insulators.

b. The paragraphs which follow in this section help in localizing the fault to the defective stage.

41. Visual Inspection

Practically all trouble in Hybrid Circuit Network TA-255/TT will be caused by vibration or rough handling. Inspect the equipment visually for broken wires, leaking capacitors, broken terminal boards, and leaking transformers.

42. Trouble Shooting by Using Equipment Performance Checklist

a. General. The equipment performance checklist is an aid in locating trouble in the equipment. The list gives the item to be checked, conditions under which the item is to be checked, the normal indications, and the corrective measures the operator can take. To use this list, follow the items in numerical sequence.

b. Action or Condition. For some items, the information given in the action or condition column consists of switch settings under which the item is to be checked For other items, it represents action that must be taken to check the normal indication given in the normal indications column.

c. Normal Indications. The normal indications listed include the visible and audible signs that the operator should note when items are checked. If the indications are not normal, the operator should apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those the operator can make without turning in the equipment for repairs. A reference in the table to paragraphs in chapter 5 indicates that the trouble cannot be corrected by the operator and that trouble shooting must be done by the higher echelons. However, if the tactical situation requires that communication be maintained, and if the unit is not completely inoperative, the operator must keep the equipment in operation as long as it is possible to do so.

43. Equipment Performance Checklist

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	2-W LINE binding posts.	Check connections to 2-W LINE binding posts E8 and E9.		
	2	4 WIRE REC binding posts.	Check connections to 4 WIRE REC binding posts E1 and E2.		
	3	4 WIRE XMTG binding posts.	Check connections to 4 WIRE XMTG binding posts E15 and E16.		
	4	BAL VERNIER switch.	Adjust as described in paragraph 18.		
	5	BAL RES switch	Adjust as described in paragraph 18.		
	6	BO CAPACITOR SEL switch.	Adjust as described in paragraph 18.		
	7	BO CAPACITOR switch.	Adjust as described in paragraph 18.		
	8	TG-SIG CONN terminal board.	Make connections as described in paragraph 15*b*.		
START	9	Telephone Terminals CF-1-(*).	Operate dial 1 to 18, dial 4 to 0, and dial 2 to 4. Adjust MILES dial as described in paragraph 21.		
	10	Repeaters CF-3-A.	Operate dial 1 to 18, dial 4 to 0, and dial 2 to 4. Adjust MILES dial as described in paragraph 21.		
	11	At terminals and repeaters.	Set Telephone Terminals CF-1-(*) and Repeaters CF-3-A into operation as described in TM 11-341.		

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE	12	At terminals.	Press SIGNAL key lever at each terminal in turn.	Ringing signal is received at all repeaters and terminals.	If no signal is received, check terminals and repeaters in accordance with TM 11-341. Check TA-255/TT by connecting Telephone EE-8 to 2-W LINE binding posts E8 and E9. Connect another Telephone EE-8 to 4 WIRE XMTG binding posts E15 and E16. Ring through in both directions. If signal is not received in one or both directions, test TA-255/TT as described in paragraphs 54 and 59.
	13	At both terminals.	Operate TALK-MON key to TALK and carry on a two-way conversation through the phones.	Conversation is heard clearly in both directions.	If conversation cannot be heard in either direction, check all terminals and repeaters. Check TA-255/TT by connecting Telephone EE-8 to 2-W LINE binding posts E8 and E9. Connect another Telephone EE-8 to 4 WIRE XMTG binding posts E15 and E16. Carry on a two-way conversation over the phones. Check for trouble in the line. If conversation is not received in one or both directions, test TA-255/TT as described in paragraphs 54 and 59.
		Note. Perform this item if telegraph equipment is connected to the TA-255/TT. TG 1 and 2 binding posts E6 and E7.	Operate telegraph equipment in usual manner for type of equipment being used.	Telegraph signals are received at distant telegraph terminal.	If normal indications are not obtained, replace TA-255/TT with another TA-255/TT. Check for trouble in the line. Check defective TA-255/TT as described in paragraphs 54 and 59.
		Note. Perform this item if telegraph equipment is connected to terminals or repeaters.			If normal indications are not obtained, check terminals and repeaters in accordance with TM 11-341.
	14	TG 1and 2 binding posts E6 and E7.	Operate telegraph equipment in usual manner for type of equipment being used.	Telegraph signals are received at distant telegraph terminal.	Check connections on TG-SIG CONN terminal board in the TA-255/TT in accordance with paragraph 15*b*. Check TA-255/TT by replacing it with another TA-255/TT. Check defective TA-255/TT equipment as described in paragraphs 54 and 59.

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE	15	Signaling and alarm circuit. (If signaling equipment is connected to terminals.)	At TA-255/TT, make connections on TG-SIG CONN terminal board as described in paragraph 15*b*. At all terminals and repeaters, press SIGNAL CUTOFF key lever down.		
			At terminal A, operate key lever on SIG panel to BATTERY position.		
			At terminal B, operate key lever on SIG panel to GROUND position.	Signal is received at terminal B.	If normal indications are not obtained, check each repeater station beginning from terminal A end in the following manner: (1) Leave key lever at terminal A on BATTERY position. (2) At first repeater from terminal A, operate key lever on SIG panel to GROUND B position. (3) If no signal is received, reverse the connections to 2-W LINE binding posts E8 and E9 at either TA-255/TT. (4) If the signal is still not received, reconnect the 2-W LINE connections at the TA-255/TT in their former positions. (5) No signal at this point indicates trouble in the equipment or line up to that point. Check terminals and repeaters in accordance with TM 11-341. Check TA-255/TT equipment by replacing with another TA-255/TT and repeat the above test. Check defective TA-255/TT equipment as described in paragraphs 54 and 59. (6) If signal is received at this point, restore key lever at the repeater to its normal position. (7) Check each repeater station in the same manner until the trouble is located. (8) When signal circuit is continuous, leave key lever on SIG panel at terminal B operated to GROUND position and silence the signal with the SIGNAL CUTOFF key.

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE	16	Signaling and alarm circuit.	Check connections to TG 1 and 2 binding posts E6 and E7.		
		(If signaling equipment is connected to TA-255/TT.)	Proceed in the same manner described for signaling equipment connected to terminals.	Signal is received at next station where signaling equipment is connected.	If normal indications are not obtained, check TA-255/TT equipment by replacing with another TA-255/TT. Check defective TA-255/TT equipment as described in paragraphs 54 and 59.

CHAPTER 4

THEORY OF HYBRID CIRCUIT NETWORK TA-255/TT

44. General

a. Hybrid Circuit Network TA-255/TT receives signals from the sending branch of the four-wire line and couples them to the two-wire line. The hybrid network also couples the received signals from the two-wire line to the receiving branch of the four-wire line. The hybrid arrangement isolates the receiving branch of the four-wire line from the sending branch of the four-wire line.

b. To avoid possible singing at frequencies outside the normal transmission band (par. 5), the incoming signals from the two-wire line pass through a low-pass filter after leaving the hybrid transformer arrangement.

c. The balancing network matches the impedance of the two-wire line. The building-out capacitor unit augments the reactance of the balancing network or the line at high frequencies.

d. The telegraph composite set provides two d-c circuits for the operation of signaling and telegraph equipment with the hybrid circuit. The telegraph noise filters reduce noise and telegraph thump in the telephone circuits.

e. The midpoint of line windings 3-4 and 7-8 of hybrid transformer T1 is grounded to reduce noise which might result from any shunt unbalance in the telegraph composite set (par. 49) if no phantom is used. If the phantom is used, the center point of the phantom circuit will be grounded (par. 15*c*).

f. The theory of the telephone circuit is discussed in paragraphs 45 through 48. The theory of the telegraph circuit is discussed in paragraph 49. Figure 16 is a block diagram of the circuits of Hybrid Circuit Network TA-255/TT.

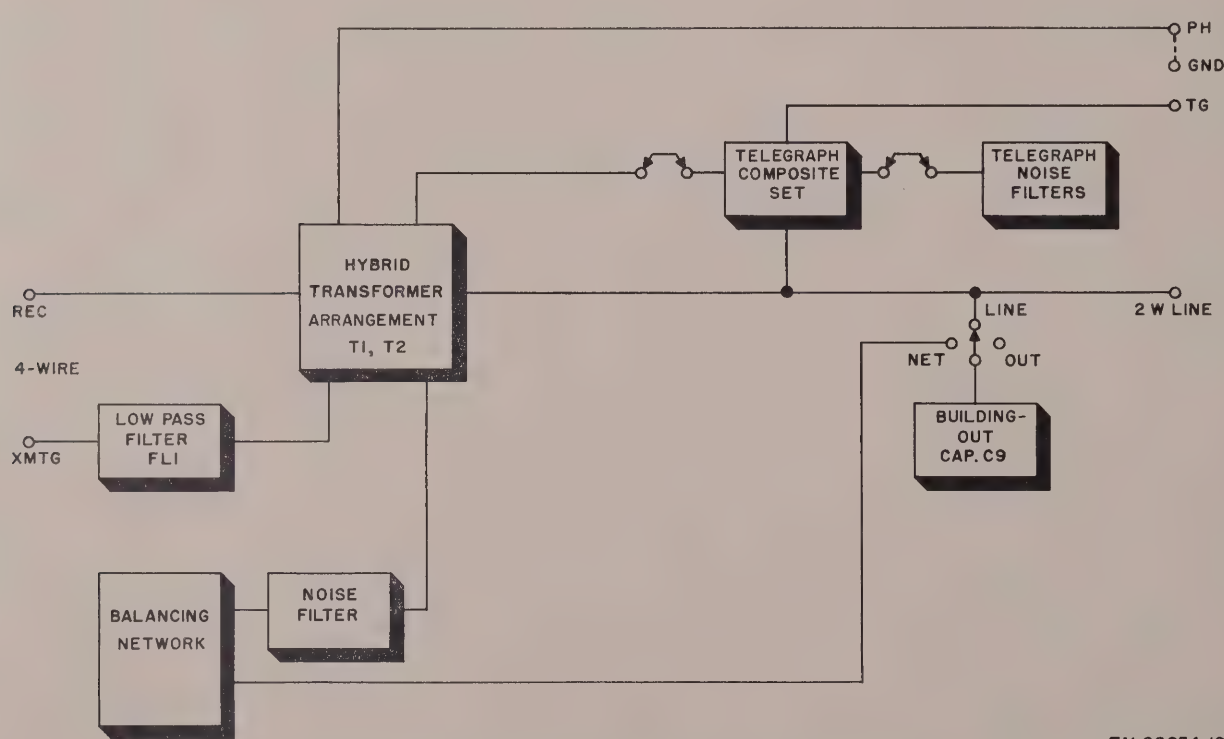


Figure 16. Hybrid Circuit Network TA-255/TT, block diagram.

45. Hybrid Transformer Circuit

a. General. The analysis of the hybrid transformer circuit is given by first analyzing the basic theory of a hybrid transformer of the type contained in the TA-255/TT and then relating this basic theory to the actual equipment. The information in subparagraph *b* below explains why the hybrid transformer arrangement is necessary in converting four-wire operation to two-wire operation.

b. Necessity for Arrangement. To amplify the signals of a two-way telephone conversation, two amplifiers must be used since an amplifier can amplify only in one direction. Therefore, to amplify a two-way conversation in both directions, a four-wire line is necessary, a two-wire pair for each amplifier. If the two amplifiers are connected to the same two-wire line (fig. 17), a feedback occurs, because a circulating current flows from the output of one amplifier through the other amplifier and back to the first, producing the same effect as an oscillator. Thus, the circuit oscillates or sings and is useless for transmission of intelligible speech. This condition can be eliminated by connecting a hybrid transformer into the circuit to separate the two directions of transmission. The hybrid transformer is connected at each two-wire, four-wire junction in a transmission line. These junctions occur at the terminals and the repeaters. The analysis of the hybrid transformer arrangement is described in subparagraphs *c* and *d* below.

c. Function, Input from 4 WIRE REC LINE. Figure 18 shows the energy flow in the hybrid transformer arrangement when a signal enters from the four-wire equipment (Telephone Terminals CF-1-(*) or Repeaters CF-3-A). The telephone signal from the 4 WIRE REC line enters the hybrid transformer arrangement. The incoming signal causes energy to flow through windings 1-2 and 5-6 of transformer T1. The direction of the energy flow is shown in figure 18 by the arrows. Equal magnetic fields are produced in each of the windings and energy is coupled into the remaining four windings in the directions shown by the arrows. Transformer T1 is coupled to transformer T2 so that an equal amount of energy is coupled into each winding of transformer T2. However, windings 9-10 and 11-12 of transformer T1 are connected to network windings 11-12 and 9-10 of T2 to reverse the polarity of the windings of one transformer with respect to the other. Because of the reverse polarity of these windings, the energy entering windings 5-6 of transformer T2 is flowing in the opposite direction to the energy in windings 1-2 of the same transformer. Since the energy coupled into each of the two windings is of equal magnitude, no current flows into the 4 WIRE XMTG side of the circuit. Therefore, the energy is divided equally between the two-wire line and the balancing network. The energy flowing into the balancing network is dissipated in the balancing network in the form of heat.

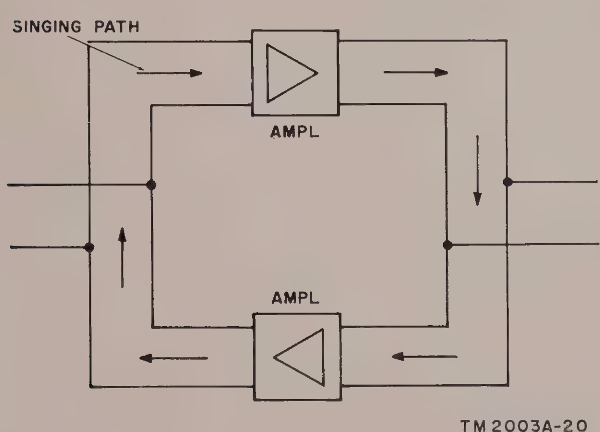


Figure 17. Feedback circuit illustrating necessity for hybrid transformer arrangement.

d. Function, Input from 2-W LINE. Figure 19 shows the energy flow in the hybrid transformer arrangement when a signal enters from the two-wire line. The signal from the two-wire line causes energy to flow through windings 3-4 and 7-8 of transformer T2. The magnetic field in transformer T2 couples energy into the remaining four windings in transformer T2. Because of the physical coupling between transformers T2 and T1, equal energy is conducted or induced into each of the six windings of transformer T1. Windings 1-2 and 5-6 of transformer T1 are wound so that the quantities of energy induced into these windings add. The sum of these quantities of energy is applied to the transmitting amplifier of the associated terminal or repeater. Likewise, windings 1-2 and 5-6 of transformer T2 are wound so that the quantities of energy induced into these windings are additive. The sum of these quantities is applied to the receiving amplifier of the associated terminal or repeater. Because of the reverse connections, the quantities of energy induced into windings 9-10 and 11-12 of transformer T1 are of opposite polarity to the quantities of energy induced in windings 9-10 and 11-12 of transformer T2. The induced quantities of energy are of equal magnitude and because they are opposing, no energy is dissipated in the balancing network. Therefore the balance of this network is not important for an input from the

two-wire line. Half of the energy of the signal from the two-wire line passes through transformer T1 to the 4 WIRE REC side of the circuit and on to the transmitting amplifier of the associated terminal or repeater. This energy is dissipated in the output circuits of the transmitting amplifier and does not affect the

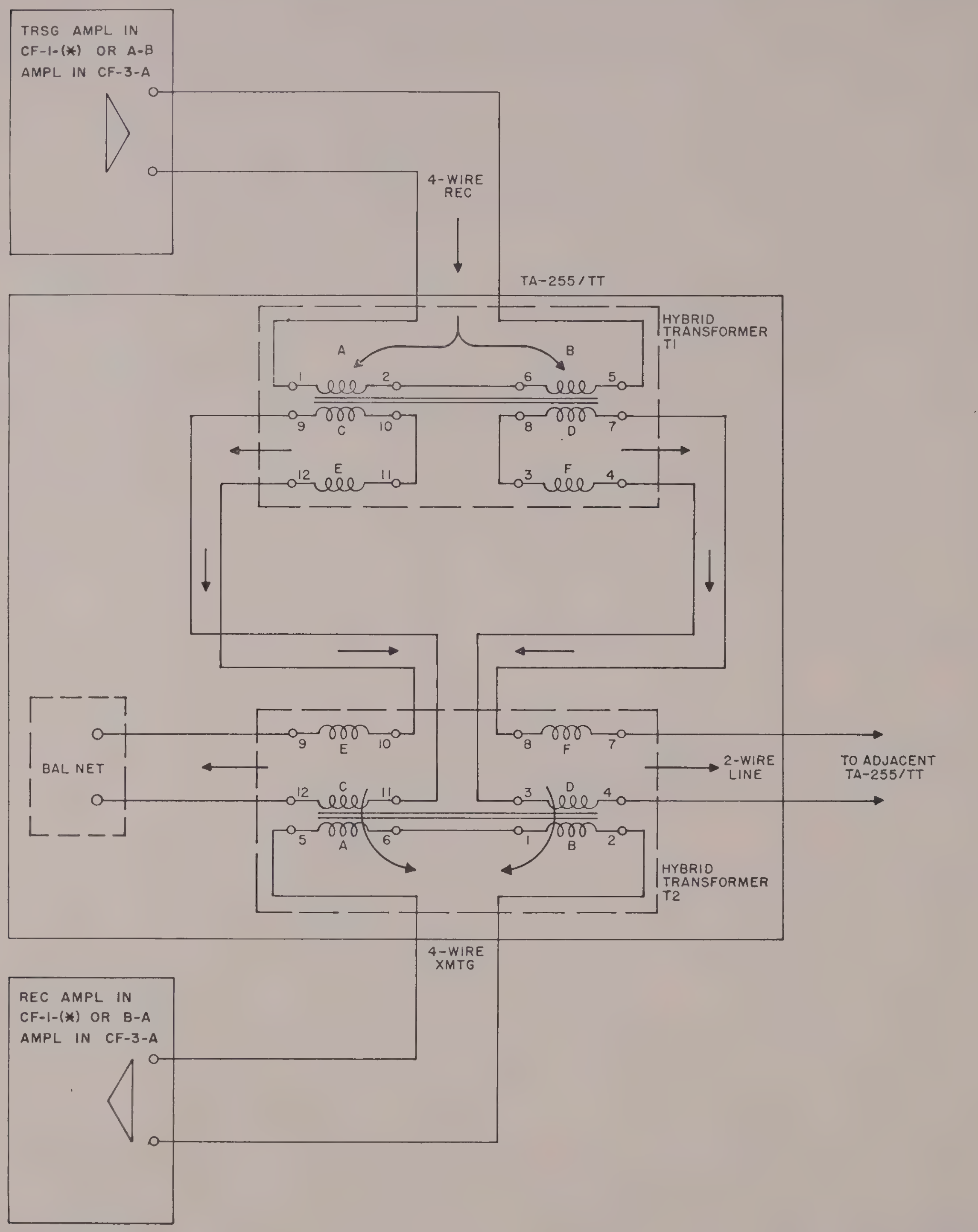


Figure 18. Direction of energy flow in a hybrid transformer circuit, 4 WIRE REC to 2-W LINE.

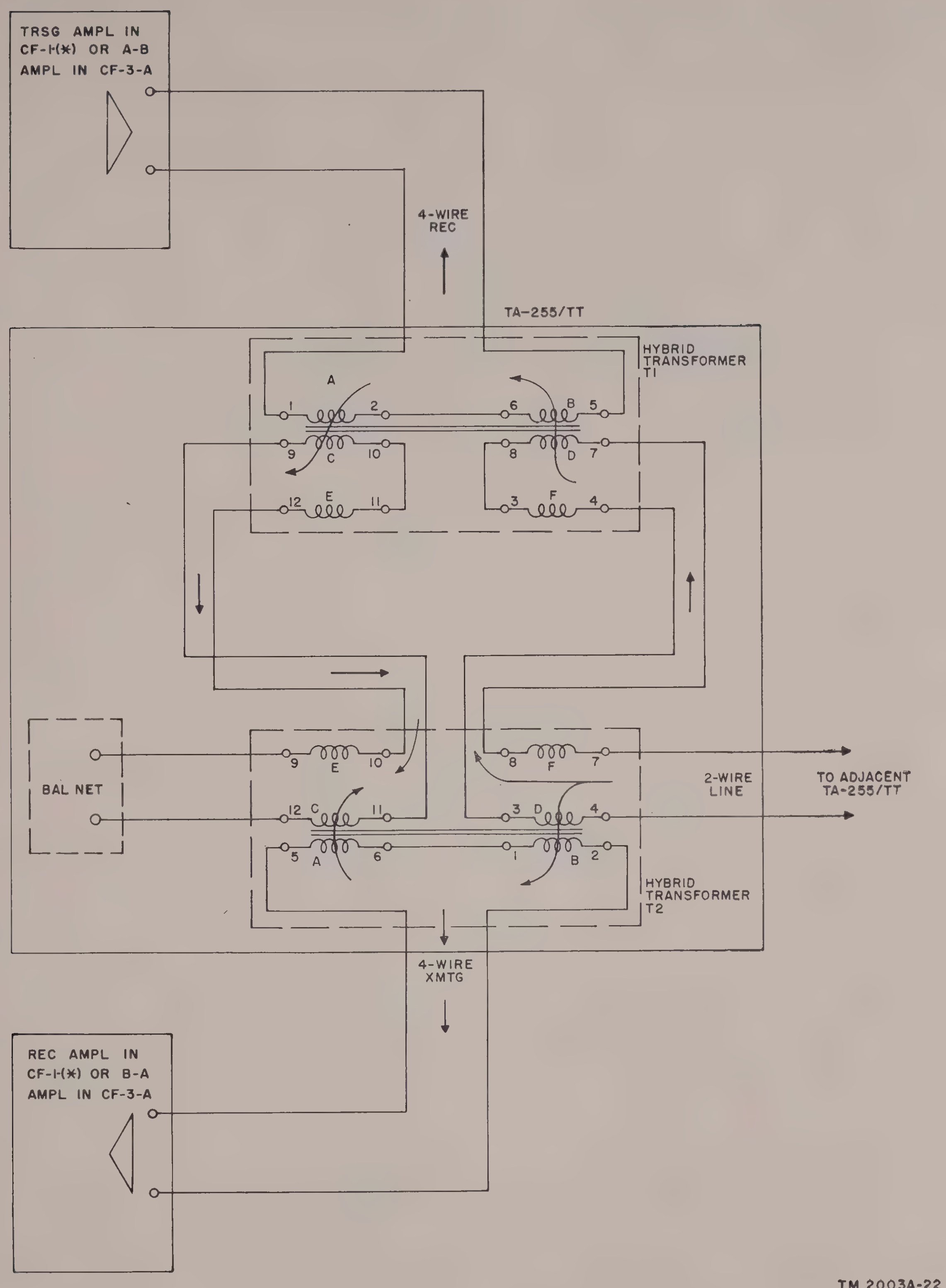


Figure 19. Direction of energy flow in hybrid transformer circuit, 2-W LINE to 4 WIRE side.

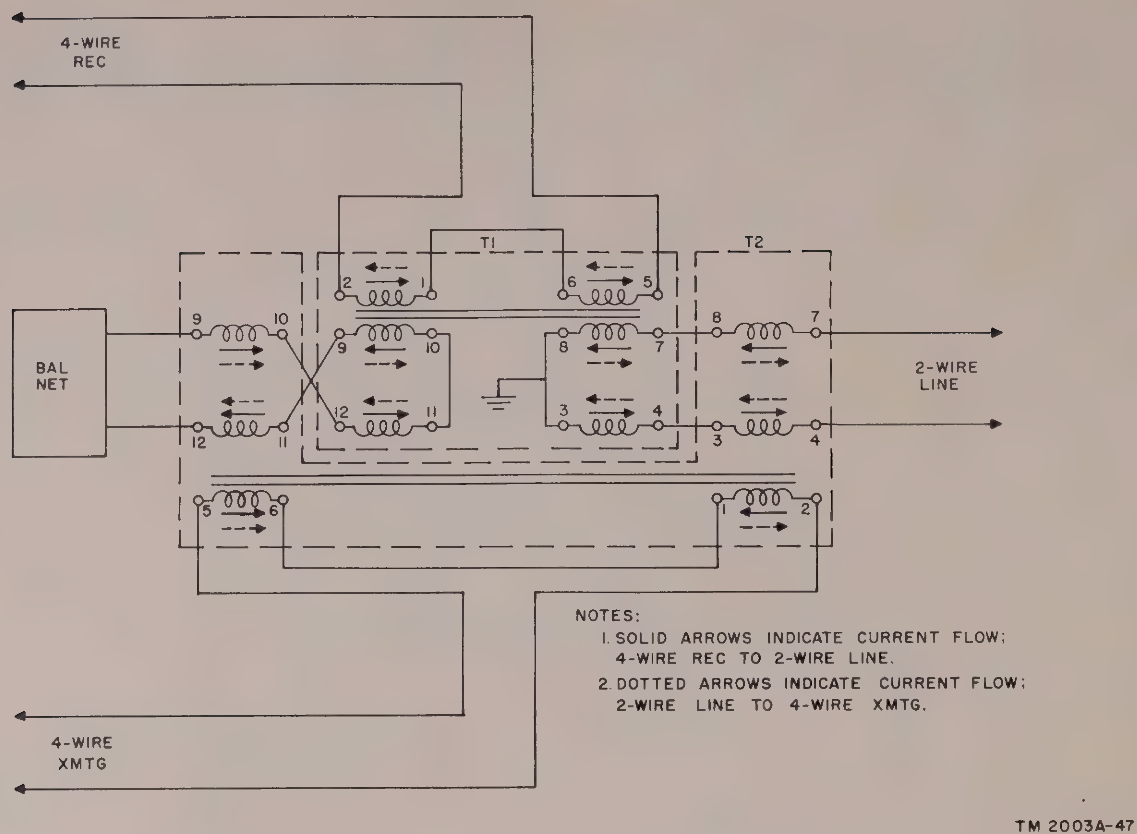


Figure 20. Hybrid Circuit Network TA-255/TT, simplified schematic.

functioning of the transmitting amplifier. The other half of the energy of the input signal passes through transformer T2 through the 4 WIRE XMTG side of the circuit and on to the receiving amplifier of the associated terminal or repeater.

e. Hybrid Circuit of the TA-255/TT. Figure 20 is a simplified schematic of the actual hybrid transformer circuit used in the TA-255/TT. The direction of the *current* entering from the four-wire side of the circuit is illustrated by the solid arrows. The dotted arrows shows the direction of the *current* when the TA-255/TT is receiving signals from the 2-wire line.

46. Balancing Network

a. The quantities of energy induced in the hybrid transformer windings from the four-wire equipment will be equal and opposite only if the impedance of the 2-W LINE is nearly equal to the impedance of the network (par. 45*c*). If these impedances are not equal, some of the energy may return to the four-wire equipment receiving amplifier and cause singing. The balancing network described in subparagraph *b* below is designed to match these impedances.

b. Figure 21 is a simplified schematic of the balancing network circuit. The circuit is divided into three parts (subpars. *c* through *e* below).

c. The incoming energy passes through capacitor C10 and retardation coil L7, which together serve to balance the telegraph composite set whether or not the noise filters are used (par. 49).

d. The balance vernier circuit is an adjustable series resistance for making fine adjustments in the balancing network. It consists of seven 10-ohm resistors connected to rotary switch S1. The balancing resistance circuit is also an adjustable series resistance for making coarse adjustments in the balancing network. It consists of five resistors, 25, 50, 100, 200, and 400 ohms, connected to screw-down contact switch S4. By manipulating the five contact screws on S4, resistance values from 0 to 775 ohms may be obtained in 25-ohm steps. Switches S1 and S4 are connected in series with low-frequency corrector switch S2.

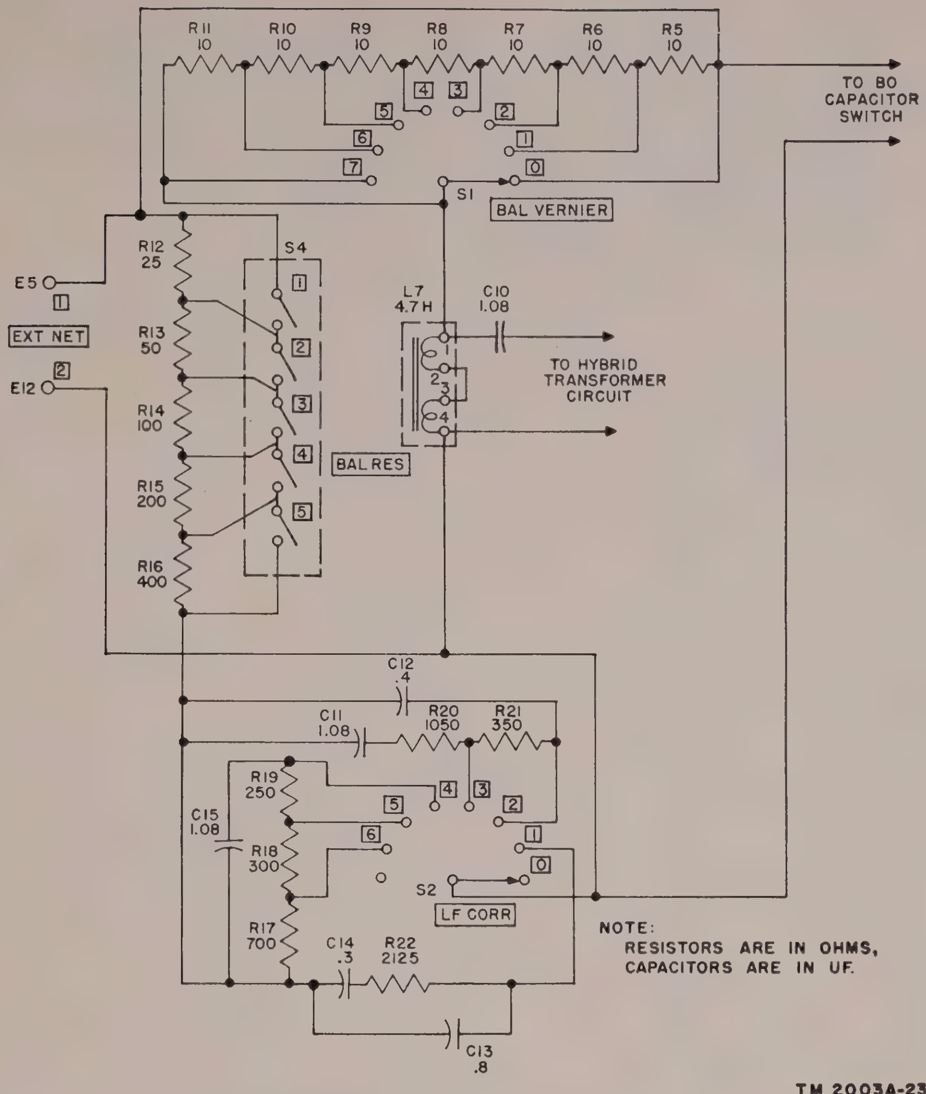


Figure 21. Balancing network circuit, simplified schematic.

e. The low-frequency corrector circuit is designed to augment the resistance and negative reactance of the line at low frequencies. The six positions on LF CORR switch S2 are for the various line facilities discussed in paragraph 9.

47. Building-out Capacitor (fig. 22)

a. The principle function of the building-out capacitor unit is to augment the reactance of the network or line at high frequencies. If the reactance of the line is more negative than that of the low-frequency corrector circuit the deficiency can be made up by connecting the building-out capacitor circuit into the network. If the reactance of the line is less negative than that of the network, the deficiency can be made up by connecting the building-out capacitor circuit across the LINE.

b. The building-out capacitor is a 10-unit capacitor connected to BO CAPACITOR SEL switches S5 and S6. A capacitance from 0 to .085 μf can be obtained by adjusting the contact screws properly (pars. 18 and 25). The building-out capacitor also is connected to BO CAPACITOR rotary switch S3, which enables the unit to be connected in parallel with the balancing network, the 2-W LINE, or switched completely out of the circuit.

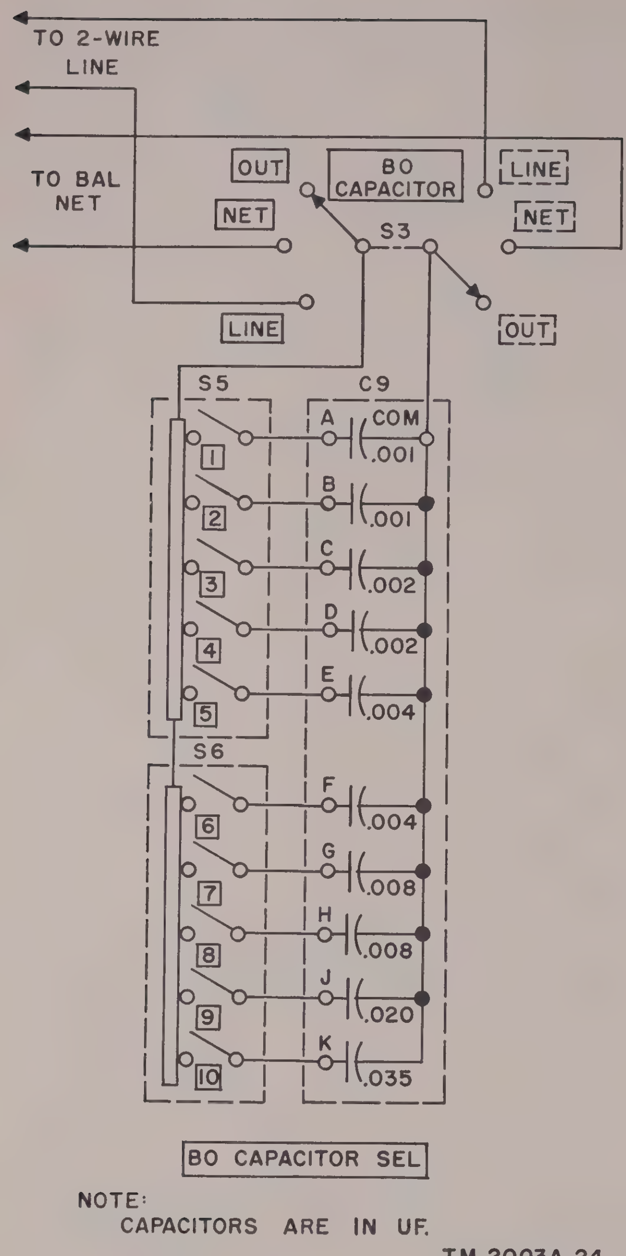


Figure 22. Building-out capacitor circuit, simplified schematic.

48. Low-pass Filter (fig. 44)

a. The incoming signals from the 2-W LINE pass through the hybrid transformer arrangement and then through low-pass filter FL1 before proceeding to the receiving amplifiers of the terminals or repeaters. This filter attenuates all frequencies over 12,000 cps. Cutting off the higher frequencies reduces the possibility of singing outside the useful frequency band.

b. The filter consists of an 11-millihenry retardation coil, a .004-μf capacitor on the hybrid side, and a .03-μf capacitor on the terminal side. These capacitors have a low reactance to frequencies over 12,000 cps. Filter FL1 introduces less than a 2-db loss in the useful frequency band.

49. Telegraph Composite Set

a. Figure 23 is a simplified schematic of the telegraph composite set with its associated telegraph noise filters. The telegraph composite set provides for two d-c telegraph circuits or one telegraph circuit and one signaling circuit.

b. The telegraph composite set consists of series and shunt elements. The series elements are the two capacitors, C7 and C8, which serve to open the d-c path between the line and hybrid transformer arrangement.

c. The shunt elements consist of two retardation coils, L3 and L4, and capacitors C3, C4, C5, and C6. The retardation coils and the capacitors provide a path for the flow of direct current without appreciably affecting transmission at voice and carrier frequencies. The shunt elements also help to reduce noise in the telephone circuit.

d. When the set is used as a terminal composite set, capacitors C3, C4, C5, and C6, respectively, are connected in parallel. When the set is used as an intermediate composite set, only C5 and C6 are used.

e. Two noise filters for reducing telegraph thump in the telephone circuit are associated with the telegraph composite set. One filter is provided for each d-c path. Each filter consists of a retardation coil (L1, L2), one-half of which is shunted by a resistor (R3, R4), and a capacitor (C1, C2) and a resistor (R1, R2) in series. The input and output terminals of each filter circuit are brought out to terminals on the TG-SIG CONN terminal strip, TB1, so that the filters may be used or omitted in the d-c paths as needed. The filters introduce a certain amount of loss in the circuit; therefore, their use is limited to conditions where telegraph thump is found to be objectionable.

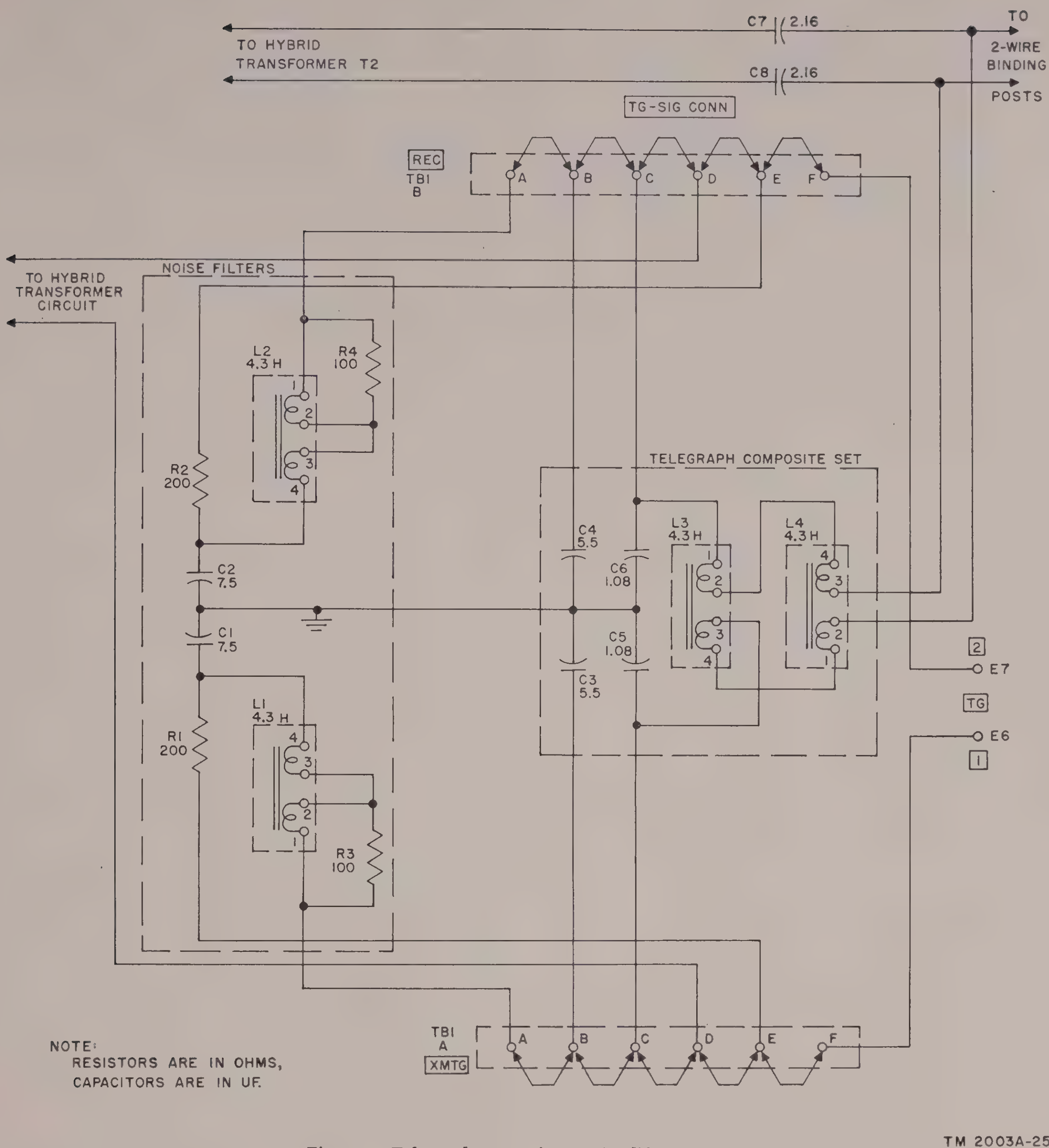


Figure 23. Telegraph composite set, simplified schematic.

CHAPTER 5

FIELD MAINTENANCE INSTRUCTIONS

Note. This chapter contains information for field maintenance of Hybrid Circuit Network TA-255/TT. The amount of repair that can be performed by units having field maintenance responsibility is limited by the tools and test equipment available, and by the skill of the repairmen.

Section I. PREREPAIR PROCEDURE

50. Tools and Materials

Tools and materials needed for performing the prerepair procedures in this section are listed in the table below:

Sig C stock No.	Name and description
6Z7500-000	Abrasive, paper: flint; #000.
6Z1989	Cloth, textile: cheesecloth; lint-free; 36″ wd.
6G1516	Polish.
QMC51-S-4385-1 (Quartermaster)	Solvent, Dry cleaning (SD).
6R38123	Tool Equipment TE-123.

51. Cleaning and Inspecting Parts

a. Inspecting Coils and Transformers.

(1) Inspect all coils and transformers for leakage and broken or bent terminal lugs which could cause shorts.

(2) Clean terminal heads with solvent (SD).

b. Inspecting Capacitors. Inspect all capacitors for possible leakage. Oil in the case or on the chassis will indicate a leaking capacitor.

c. Testing.

(1) Inspection of the parts (subpars. *a* and *b* above) may indicate that a part is defective. If a part is suspected of being defective, replace the part with one known to be in good condition. If normal operation is restored after the part is replaced, the replaced part is defective.

(2) Detailed procedures for checking any part in the TA-255/TT appear in paragraphs 53 through 61.

52. Cleaning and Inspecting Chassis

a. Cleaning. Thorough cleaning of the TA-255/TT is necessary to insure optimum performance by preventing corrosion, rust, and dust from damaging parts or causing low-resistance leakage points to ground. Remove loose dust and dirt with a brush or blower. Remove dirt and grease which adhere to the chassis and parts with a brush and cloth moistened with solvent (SD). Clean the switches with a small brush or pipe cleaner and solvent (SD).

b. Inspecting. After the TA-255/TT has been cleaned thoroughly and carefully, make a visual inspection of parts and wiring for rust, corrosion, loose connections, frayed or burned insulation, loose screws, and broken or cracked terminal boards. Carefully inspect the switches for loose or bent contacts and broken insulation. Inspect and tighten all loose setscrews and knobs.

Section II. TROUBLE SHOOTING AT FIELD MAINTENANCE LEVEL

53. Trouble-shooting Procedures

a. General. The first step in servicing a defective TA-255/TT is to sectionalize the fault, which means tracing the fault to the *circuit* responsible for the abnormal operation of the hybrid network. The second step is to localize the fault, which means tracing the fault to the defective *part* responsible for the abnormal condition. Some faults such as broken connections and shorted transformers often can be located by sight or smell. The majority of faults, however, must be localized by *checking resistance.*

Note. The hybrid network uses no power and requires no power connections.

b. Component Sectionalization and Localization. The tests listed in subparagraphs (1) through (5) below aid in isolating the source of trouble. To be effective, the procedure should be followed in the order given. Remember that the servicing procedure should cause no further damage to the TA-255/TT. First, trouble should be localized to a single stage or circuit. Then the trouble may be isolated within that stage or circuit by appropriate resistance and continuity measurements. The service procedure is summarized as follows:

(1) *Visual inspection.* The purpose of visual inspection (par. 41) is to locate any visible trouble. Through this inspection alone, the repairman frequently may discover the trouble or determine the stage in which the trouble exists. This inspection is valuable in avoiding additional damage to the receiver which might occur through improper servicing methods and in forestalling future failure.

(2) *Operational test.* The operational test (par. 57) is important because it indicates the general location of trouble. In many instances, the information gained will determine the exact nature of the fault. To utilize this information fully, all symptoms must be interpreted in relation to one another.

(3) *Resistance measurements.* These measurements (fig. 24 and par. 61) prevent further damage to the TA-255/TT and help in isolating the particular part at fault.

(4) *Trouble-shooting chart.* The troubles listed in the trouble-shooting chart (par. 58) will aid greatly in sectionalizing and localizing trouble.

(5) *Intermittent faults.* In all these tests, the possibility of intermittents should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the set. It is possible that trouble is not in the hybrid network itself but in the installation, or the trouble may be caused by external conditions. In this event, test the installation, if possible.

54. Trouble-shooting Data

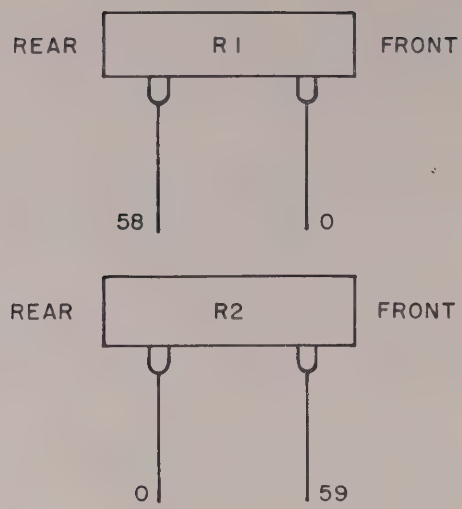
The figure references listed below will aid in the rapid location of faults.

Fig. No.	Description
11	Front view.
24	Terminal board showing resistance measurements.
25	Top view of chassis.
26	Rear view of chassis.
27	Bottom view of chassis.
41	Resistor color codes.
42	Capacitor color codes.
43	Wiring diagram.
44	Schematic diagram.

55. Test Equipment Required for Trouble Shooting

The test equipment required for trouble shooting and repairing the TA-255/TT is listed below.

Quantity	Description	Sig C stock No.
2	600-ohm, $\pm 1\%$, $\frac{1}{4}$-watt resistors	
1	Capacitor Analyzer ZM-3/U	3F3936-3
1	Test Set I-49	3F4049
1	Multimeter TS-352/U	3F4325-352
1	Test Set TS-140/PCM, c/o	3F4325-140
	Decibel Meter ME-22/PCM	3F3307.11-1
	Signal Generator SG-15/PCM	3F3901.1-15



NOTES:

1. FOR ALL TESTS, BACK OUT ALL CONTACT SCREWS ON BAL RES SWITCH S4.

2. TO TEST R5 THRU R16
   A. TAKE READING FROM BINDING POST E5.
   B. SET LF CORR SWITCH S3 ON OPEN.

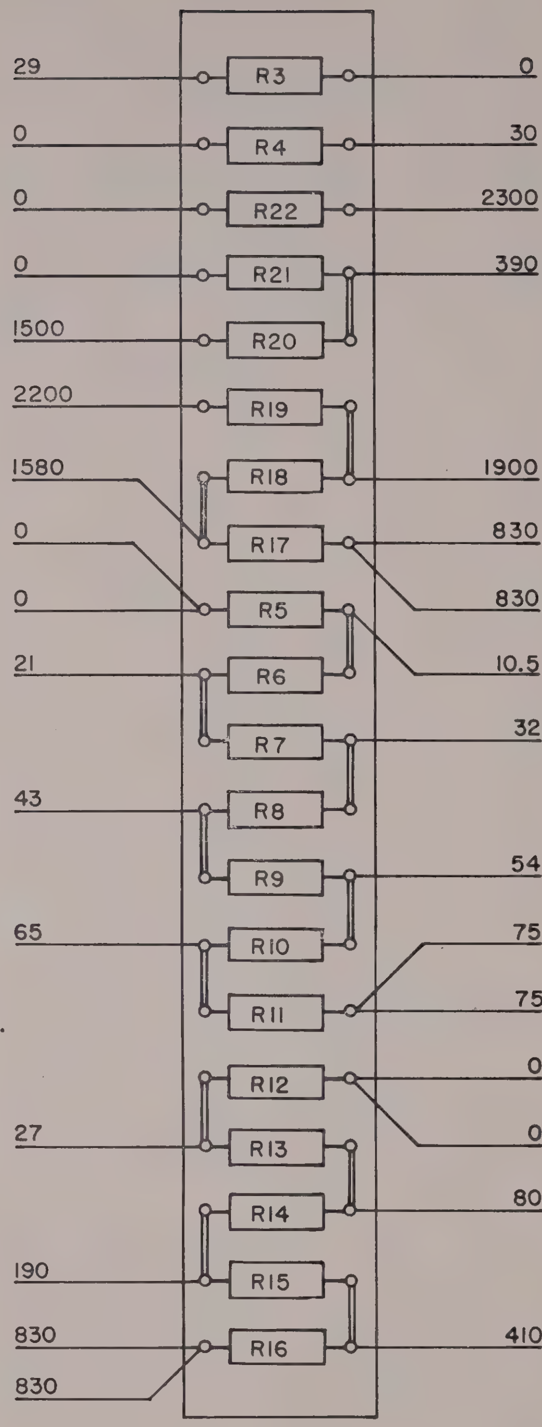
3. TO TEST R20 AND R21
   A. TAKE READING FROM BINDING POST E12.
   B. SET LF CORR SWITCH S3 ON 2.

4. TO TEST R22
   A. TAKE READING FROM BINDING POST E12.
   B. SET LF CORR SWITCH S3 ON 1.

5. TO TEST R1 AND R3
   A. TAKE READING FROM BINDING POST E6.
   B. CONNECT A-B-C-D-E-F ON XMTG SIDE OF TB1.

6. TO TEST R2 AND R4
   A. TAKE READING FROM BINDING POST E7.
   B. CONNECT A-B-C-D-E-F ON REC SIDE OF TB1.

7. RESISTANCE VALUES ARE IN OHMS.



TM 2003A-26

Figure 24. Terminal board, showing resistance measurements.

56. General Precautions

Whenever the TA-255/TT is serviced, observe the following precautions:

a. Be careful when the unit is exposed; do not bend cables, switches, or wires.

b. Careless replacement of parts often makes new faults inevitable. Note the following points:

(1) Before a part is unsoldered, note the position of the leads. If the part, such as a transformer, has a number of connections, tag each of the leads.

(2) Be careful not to damage other leads by pulling or pushing them out of the way.

(3) Do not allow drops of solder to fall into the set, since they may cause short circuits.

(4) A carelessly soldered connection may create a new fault. It is important to make well-soldered joints, since a poorly soldered joint is one of the most difficult faults to find.

57. Operational Test

To check the TA-255/TT for normal operation, operate the equipment as described in the equipment performance checklist (par. 43). This checklist is important because it frequently indicates the general location of trouble.

58. Trouble-shooting Chart

The following chart is supplied as an aid in locating trouble in the TA-255/TT. This chart lists the symptoms which the repairman can observe while making a few simple tests. Once the trouble has been localized to a stage or circuit, resistance measurements of this stage or circuit ordinarily should be sufficient to isolate the defective part. Normal resistance measurements are given in figure 24 and paragraph 61. Refer to figure 25 for identification and location of parts as seen from the top of the chassis. Figure 27 shows the location of parts as seen from the bottom of the chassis. For identification of parts mounted at the rear, refer to figure 26. Figure 43 is a wiring diagram which is useful when testing, locating, and replacing parts.

Symptom	Probable Trouble	Correction
1. Voice signal will not pass through network hybrid.	Poor connections at binding posts.	Check all binding post connections. Refer to paragraph 15.
	Low pass noise filter, FL1, not functioning properly.	Check FL1 by taking resistance readings (par. 61). Test in accordance with paragraph 59*d*. Replace if defective.
	Hybrid transformer circuit not operating properly.	Take resistance readings at T1 and T2 (par. 61). Make balance test in accordance with paragraph 59*f*.
2. Hybrid network transmits a steady tone (singing).	Balancing network not adjusted properly.	Adjust balancing network in accordance with paragraph 25. Test in accordance with paragraph 59*c*.
	LF CORR switch not adjusted properly or defective.	Adjust LF CORR switch according to paragraph 25. Test in accordance with paragraph 59*g*. Replace any defective part.
	BO CAPACITOR switch not adjusted properly or defective.	Adjust BO CAPACITOR switch in accordance with paragraph 25. Test in accordance with paragraph 59*h*. Replace the unit if found defective in any section.
	Defective switch.	Check switches. S1, S3, S4, S5 and S6. Replace any defective switch.

Symptom	Probable Trouble	Correction
3. Telegraph signals cannot be transmitted through the unit.	Poor connections at TG-SIG CONN terminal strip, TB1.	Check all connections at TG-SIG CONN terminal strip TB1, in accordance with paragraph 15.
	Retardation coils L3 and L4 not operating properly.	Take resistance measurements at L3 and L4 (par. 61). Test in accordance with paragraph 59*i*.
	Capacitors C3, C4, C5, C6, C7 or C8 defective.	Check capacitors (fig. 27) and replace any defective capacitors. Test in accordance with paragraph 59*i*.
4. Telegraph thump is received in the traffic circuits.	Telegraph noise filters not connected properly.	Check all connections on TG-SIG CONN terminal strip TB1. Refer to paragraph 15. Test noise filters in accordance with paragraph 59*i*.
	Retardation coils L1 or L2 not operating properly.	Check L1 and L2 (par. 61). Test in accordance to paragraph 59*i*. Replace if defective.
	Capacitors C1 and C2 defective.	Check C1 and C2 (fig. 27) and replace if defective.
	Resistors R1, R2, R3 or R4 defective.	Check R1, R2, R3 and R4 and replace any defective resistor.

LEGEND FOR FIGURE 25

C13. Low-frequency corrector capacitor.
H1. Cam-actuated fastener pin.
H2. Cam-actuated fastener grommet.
E9. 2-W LINE binding post.
E18. Ground binding post.
C11. Low-frequency corrector capacitor.
E8. 2-W LINE binding post.
E17. Phantom binding post.
E10. 2-W LINE protector block.
XE10. 2-W LINE protector block holder.
E6. TG 1 binding post.
C4. Telegraph composite set capacitor.
E11. 2-W LINE protector block.
XE11. 2-W LINE protector block holder.
E7. TG 2 binding post.
S2. Low-frequency corrector switch.
C7. Telegraph composite set series capacitor.
E5. EXT NET binding post 1.
S3. Building-out capacitor switch.
E12. EXT NET binding post 2.
S1. Balance vernier switch.
C8. Telegraph composite set series capacitor.
C2. Telegraph noise filter capacitor.
E3. 4 WIRE REC protector block.
XE3. 4 WIRE REC protector block holder.
E13. 4 WIRE XMTG protector block.
XE13. 4 WIRE XMTG protector block holder.
E4. 4 WIRE REC protector block.
XE4. 4 WIRE REC protector block holder.
C1. Telegraph noise filter capacitor.
E14. 4 WIRE XMTG protector block.
XE14. 4 WIRE XMTG protector block holder.
E1. 4 WIRE REC binding post.
E15. 4 WIRE XMTG binding post.
C5. Telegraph composite set capacitor.
E2. 4 WIRE REC binding post.
E16. 4 WIRE XMTG binding post.
H2. Cam-actuated fastener grommet.
H1. Cam-actuated fastener pin.
C6. Telegraph composite set capacitor.
L5. Lightning drainage coil, 2-wire.
L4. Telegraph composite set coil.
L3. Telegraph composite set coil.
C3. Telegraph composite set capacitor.
L7. Balancing network noise filter coil.
C12. Low-frequency corrector capacitor.
L1. Telegraph noise filter coil.
L2. Telegraph noise filter coil.
T2. Hybrid transformer.
T1. Hybrid transformer.
C15. Low-frequency corrector capacitor.
C9. Building-out capacitor.
C10. Balancing network noise filter capacitor.

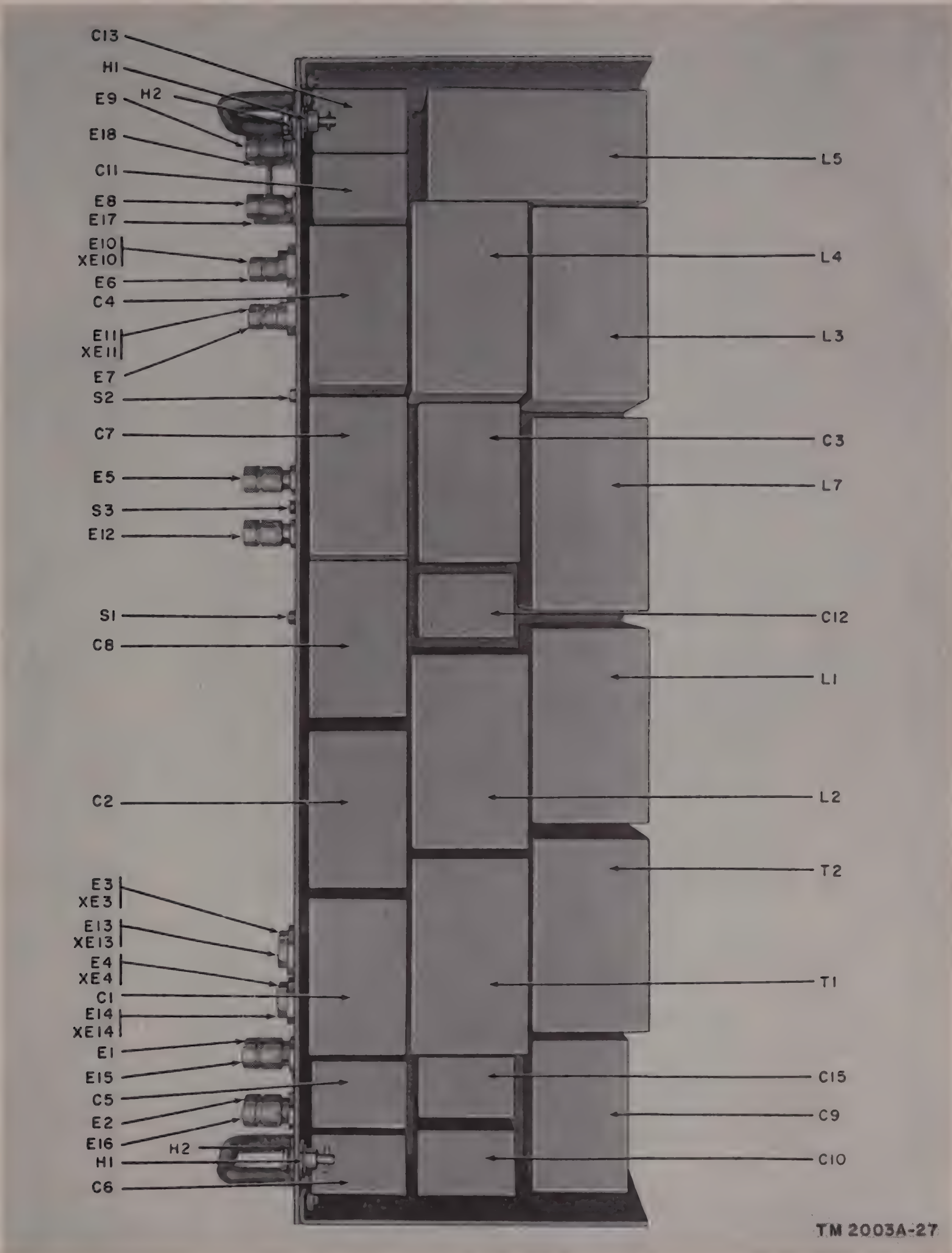


Figure 25. Hybrid Circuit Network TA-255/TT, top view of chassis showing location of parts.

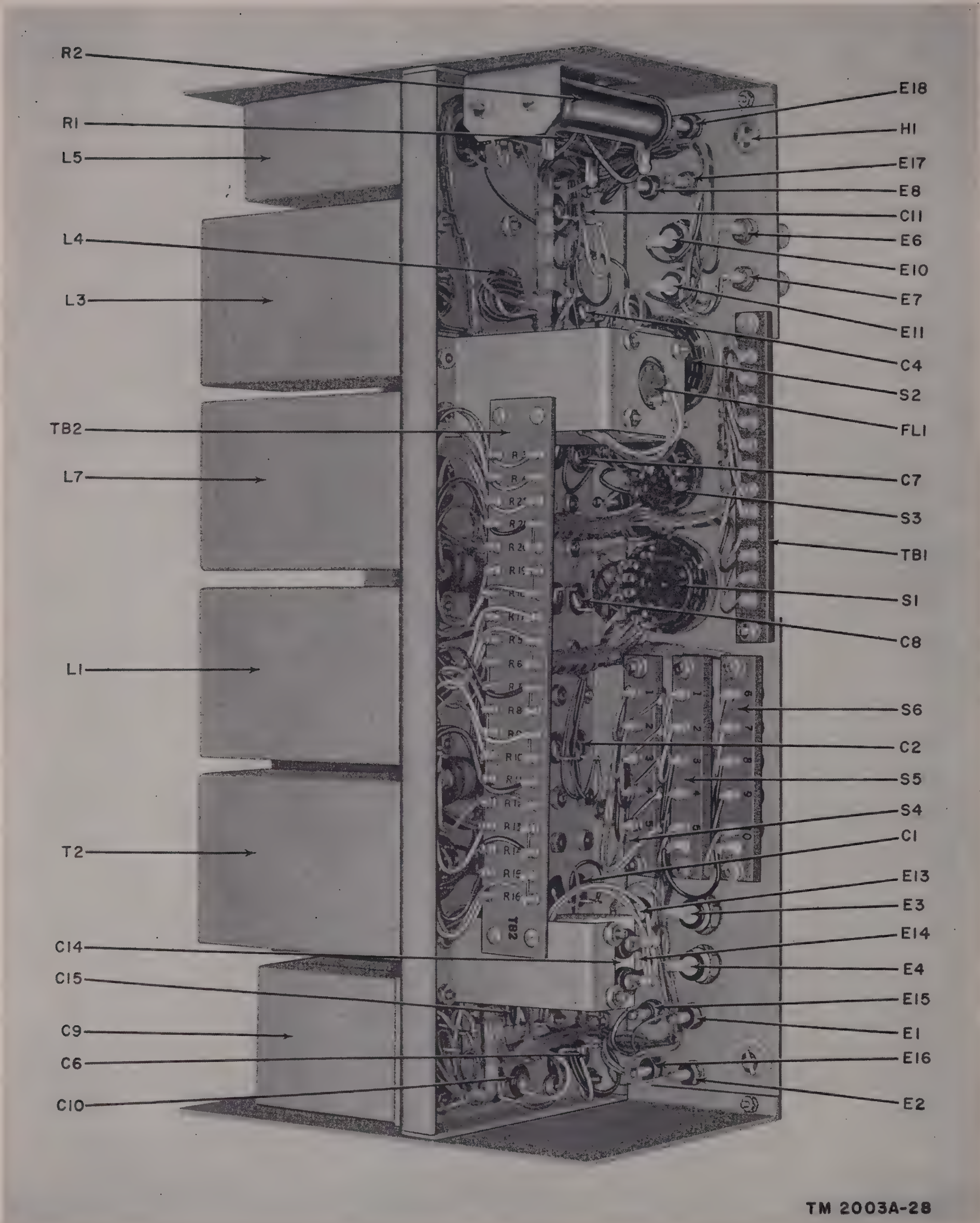


Figure 26. Hybrid Circuit Network TA-255/TT, rear view of chassis showing location of parts.

LEGEND FOR FIGURE 26

R2. Telegraph noise filter resistor.
R1. Telegraph noise filter resistor.
L5. Lightning drainage coil, 2-wire.
L4. Telegraph composite set coil.
L3. Telegraph composite set coil.
TB2. Resistor board.
L7. Balancing network noise filter coil.
L1. Telegraph noise filter coil.
T2. Hybrid transformer.
C14. Low-frequency corrector capacitor.
C15. Low-frequency corrector capacitor.
C9. Building-out capacitor.
C6. Telegraph composite set capacitor.
C10. Balancing network noise filter capacitor.
E18. Ground binding post.
H1. Cam-actuated fastener pin.
E17. Phantom binding post.
E8. 2-W LINE binding post.
C11. Low-frequency corrector capacitor.
E6. TG 1 binding post.
E10. 2-W LINE protector block.
E7. TG 2 binding post.
E11. 2-W LINE protector block.
C4. Telegraph composite set capacitor.
S2. Low-frequency corrector switch.
FL1. Low-pass filter.
C7. Telegraph composite set series capacitor.
S3. Building-out capacitor switch.
TB1. Telegraph signal connection strip.
S1. Balance vernier switch.
C8. Telegraph composite set series capacitor.
S6. Building-out capacitor selector switch.
C2. Telegraph noise filter capacitor.
S5. Building-out capacitor selector switch.
S4. Balancing resistor switch.
C1. Telegraph noise filter capacitor.
E13. 4 WIRE XMTG protector block.
E3. 4 WIRE REC protector block.
E14. 4 WIRE XMTG protector block.
E4. 4 WIRE REC protector block.
E15. 4 WIRE XMTG binding post.
E1. 4 WIRE REC binding post.
E16. 4 WIRE XMTG binding post.
E2. 4 WIRE REC binding post.

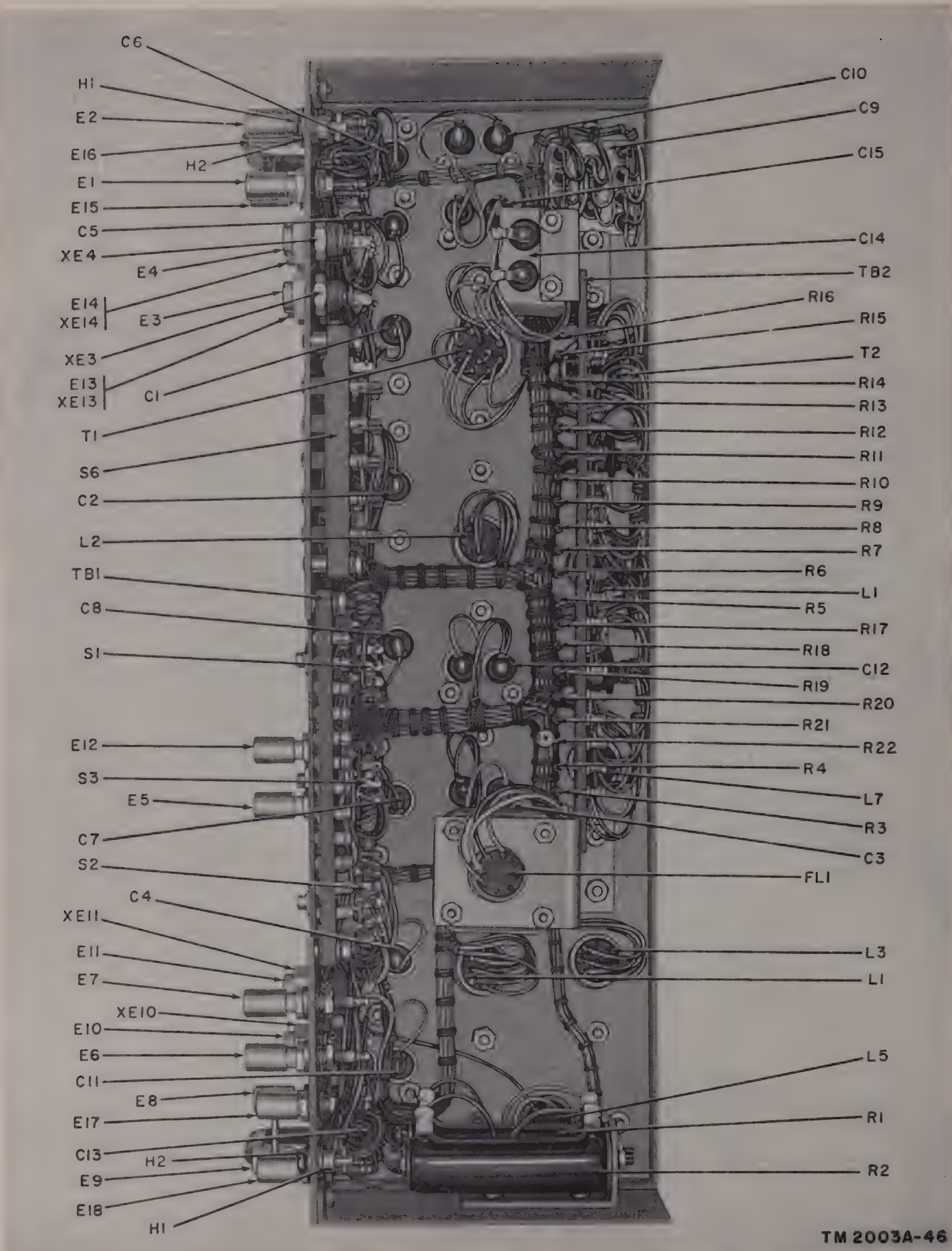


Figure 27. Hybrid Circuit Network TA-255/TT, bottom view of chassis showing location of parts.

C6.	Telegraph composite set capacitor.
H1.	Cam-actuated fastener pin.
H2.	Cam-actuated fastener grommet.
E2.	4 WIRE REC binding post.
E16.	4 WIRE XMTG binding post.
E1.	4 WIRE REC binding post.
E15.	4 WIRE XMTG binding post.
C5.	Telegraph composite set capacitor.
XE4.	4 WIRE REC protector block holder.
E4.	4 WIRE REC protector block.
E14.	4 WIRE XMTG protector block.
XE14.	4 WIRE XMTG protector block holder.
E3.	4 WIRE REC protector block.
XE3.	4 WIRE REC protector block holder.
E13.	4 WIRE XMTG protector block.
XE13.	4 WIRE XMTG protector block holder.
C1.	Telegraph noise filter capacitor.
T1.	Hybrid transformer.
S6.	Building-out capacitor selector switch.
C2.	Telegraph noise filter capacitor.
L2.	Telegraph noise filter coil.
TB1.	Telegraph-signaling connection strip.
C8.	Telegraph composite set series capacitor.
S1.	Balance vernier switch.
E12.	EXT NET 2 binding post.
S3.	Building-out capacitor switch.
E5.	EXT NET 1 binding post.
C7.	Telegraph composite set series capacitor.
S2.	Low-frequency corrector switch.
C4.	Telegraph composite set capacitor.
XE11.	2-W LINE protector block holder.
E11.	2-W LINE protector block.
E7.	TG 2 binding post.
XE10.	2-W LINE protector block holder.
E10.	2-W LINE protector block.
E6.	TG 1 binding post.
C11.	Low-frequency corrector capacitor.
E8.	2-W LINE binding post.
E17.	Phantom binding post.
C13.	Low-frequency corrector capacitor.
H2.	Cam-actuated fastener grommet.
E9.	2-W LINE binding post.
E18.	Ground binding post.
H1.	Cam-actuated fastener pin.
C10.	Balancing network noise filter capacitor.
C9.	Building-out capacitor.
C15.	Low-frequency corrector capacitor.
C14.	Low-frequency corrector capacitor.
TB2.	Resistor board.
R16.	Low-frequency corrector resistor.
R15.	Balancing resistor.
T2.	Hybrid transformer.
R14.	Balancing resistor.
R13.	Balancing resistor.
R12.	Balancing resistor.
R11.	Balancing resistor.
R10.	Balancing resistor.
R9.	Balancing resistor.
R8.	Balancing resistor.
R7.	Balancing resistor.
R6.	Balancing resistor.
L1.	Telegraph noise filter coil.
R5.	Balance vernier resistor.
R17.	Low-frequency corrector resistor.
R18.	Low-frequency corrector resistor.
C12.	Low-frequency corrector capacitor.
R19.	Low-frequency corrector resistor.
R20.	Low-frequency corrector resistor.
R21.	Low-frequency corrector resistor.
R22.	Low-frequency corrector resistor.
R4.	Telegraph noise filter resistor.
L7.	Balancing network noise filter coil.
R3.	Telegraph noise filter resistor.
C3.	Telegraph composite set capacitor.
FL1.	Low-pass filter.
L3.	Telegraph composite set coil.
L1.	Telegraph noise filter coil.
L5.	Lightning drainage coil, 2-W LINE.
R1.	Telegraph noise filter resistor.
R2.	Telegraph noise filter resistor.

59. Circuit Tests for Trouble Shooting

a. General. The following information is supplied as a further aid in locating trouble in Hybrid Circuit Network TA-255/TT. By making the simple tests listed below most troubles can be localized and corrected rapidly. Before making the tests outlined below, remove all jumper wires from the terminals on TG-SIG CONN terminal strip TB1. Screw down all contact posts on the BAL RES and BO CAPACITOR SEL contact switches.

Note. For all tests described in subparagraphs *d* through *j* below, the output of the oscillator should be 600 ohms impedance with 0 dbm output, and the input to the transmission measuring set should be 600 ohms impedance.

b. Preliminary Test. Remove the chassis from the case by releasing the four cam-actuated fasteners at each corner of the panel. Connect a ground to GND binding post. Make the preliminary test in the sequence indicated in the following chart:

Action	Normal indications	Corrective measures
1. Remove all LINE and CABLE PROTECTOR blocks by unscrewing from front of panel. Test for ground with multimeter.	Ground should be found between lug on back of panel and chassis of each of the four CABLE PROTECTORS.	If ground is not found at any of these points, remove the protector block holders and make a bare metal contact between the holder and the panel by scraping with a knife or file. Then replace holders.
	At the two LINE PROTECTORS (fig. 11) there should be approximately 4 ohms resistance to ground.	If the reading is 0 or infinity, L5 or the connections to L5 are defective. Check L5 and replace if necessary.
2. Take a reading at each terminal lug of each protector without ground.	There should be no ground at any of these points.	If ground is found at any of these points, there is a broken insulator washer in the protector holder or the terminal lug is short-circuited to chassis.
3. Restore the protectors to the holders and check all binding posts for ground.	There should be no ground at any of these points.	If ground is found at any of these points, check for broken insulator washers and defective wiring.
4. Check all terminals on the REC side of the TG-SIG CONN terminal strip, TB1, for ground.	There should be no ground at any of these points.	If ground is found at terminal A, L2 or its associated wiring is defective. If ground is found at terminal B, C4 or the associated wiring is defective. If ground is found at terminal C, C6 or L3 or the associated wiring is defective. If ground is found at terminal D, T1 or the associated wiring is defective. If ground is found at terminal E, R2 or C2 or the associated wiring is defective. If ground is found at terminal F, binding post E7 is short-circuited. Check for broken insulator washers at E7. Replace any part found to be defective.
5. Check all terminals on the XMTG side of the TG-SIG CONN terminal strip, TB1, for ground.	There should be no ground at any of these points.	If ground is found at terminal A, L1 or the associated wiring is defective. If ground is found at terminal B, C3 or its associated wiring is defective. If ground is found at terminal C, C5 or L3 or the associated wiring is defective. If ground is found at terminal D, T2 or its associated wiring is defective. If ground is found at terminal E, R1 or C1 or the associated wiring is defective. If ground is found at terminal F, binding post E6 is short-circuited. Check for broken insulator washer at E6. Replace any defective part.
6. Check for an open circuit on the TG-SIG CONN terminal strip, TB1, between REC terminal A and XMTG terminal A.	Reading should be infinity.	If the reading is not infinity, C1 and C2 or C1 and C4 are shorted. Check and replace any defective capacitor.

Action	Normal indications	Corrective measures
7. Check for an open circuit on the TG-SIG CONN terminal strip, TB1, between REC terminal B and XMTG terminal B.	Reading should be infinity.	If the reading is not infinity, C3 and C4 are defective. Check and replace any defective capacitor.
8. Check for an open circuit on the TG-SIG CONN terminal strip, TB1, between REC terminal C and XMTG terminal C.	Reading should be infinity.	If the reading is not infinity, C5, C6, C7, C8, L3, or L4 is defective. Check and replace any defective part.
9. Measure resistance on the TG-SIG CONN terminal strip, TB1, between XMTG terminal A and XMTG terminal E.	Reading should be between 230 and 330 ohms.	If this reading is not obtained, R1, R3, or L1 is defective. Check and replace any defective part.
10. Measure resistance on the TG-SIG CONN terminal strip, TB1, between REC terminal A and REC terminal E.	Reading should be between 230 and 330 ohms.	If this reading is not obtained, R2, R4, or L2 is defective. Check and replace any defective part.
11. Measure resistance on the TG-SIG CONN terminal strip, TB1, between XMTG terminal C and 2-W LINE binding post E8.	Reading should be between 68 and 108 ohms.	If this reading is not obtained, L3 or L4 is defective. Check and replace either coil if defective.
12. Measure resistance on the TG-SIG CONN terminal strip, TB1, REC terminal C or 2-W LINE binding post E9.	Reading should be between 68 and 108 ohms.	If this reading is not obtained, L3 or L4 is defective. Check and replace either coil if defective.
13. Measure resistance on the TG-SIG CONN terminal strip, TB1, XMTG terminal D to 4 WIRE binding post E15.	Reading should be between 14 and 23 ohms.	If this reading is not obtained, T2 or FL1 is defective. Check and replace either part if defective.
14. Measure resistance on the TG-SIG CONN terminal strip, TB1, XMTG terminal D to 4 WIRE binding post E16.	Reading should be between 14 and 23 ohms.	If this reading is not obtained, T2 or FL1 is defective. Check and replace any defective part.
15. Measure resistance on the TG-SIG CONN terminal strip, TB1, REC terminal D to 4 WIRE binding post E2.	Reading should be between 14 and 22 ohms.	If this reading is not obtained, T1 or its associated wiring is defective. Check and replace T1 if necessary.
16. Measure resistance on the TG-SIG CONN terminal strip, TB1, REC terminal D to 4 WIRE binding post E1.	Reading should be between 14 and 22 ohms.	If this reading is not obtained, T1 or its associated wiring is defective. Check T1 and replace if necessary.
17. Measure resistance on the TG-SIG CONN terminal strip, TB1, XMTG terminal F to TG binding post E6.	Reading should be 0.	If this reading is not obtained, wiring is defective. Check and replace broken wires.
18. Measure resistance from the TG-SIG CONN terminal strip, TB1, REC terminal F to TG binding post E7.	Reading should be 0.	If this reading is not obtained, wiring is defective. Check and replace broken wires.

c. Test of Balancing Resistor Circuit. Test the balancing resistor circuit in the following manner:

(1) Operate the LF CORR switch, S2, to OPEN, the BO CAPACITOR switch, S3, to OUT, and the BAL VERNIER switch, S1, to O.

(2) Check to insure that all five contact posts of the BAL RES contact switch, S4, are screwed down.

(3) Measure the resistance between EXT NET binding post E5 and the terminal on C14

associated with the balancing network. This terminal will have a yellow wire connected to it. There should be a zero resistance between these points.

(4) If no short circuit is found in the procedure of subparagraph (3) above, check the associated wiring and each section of BAL RES switch S4 contact posts for loose and dirty contacts.

(5) Back out contact post 1 on the BAL RES contact switch, S4, and measure the resistance with Test Set I-49, between the points specified in subparagraph (3) above. Repeat the measurement for contact posts 2, 3, 4, and 5 in turn. In each case all contact posts except the one under test should be screwed down. The resistance for each case should be as follows:

Contact post unscrewed	Test for resistor	Resistance (ohms)
1	R12	25 ±3
2	R13	50 ±3
3	R14	100 ±6
4	R15	200 ±10
5	R16	400 ±40

(6) If the requirement is not met in any case as outlined in subparagraph (5) above, check to insure that the contact post under test opens and closes the circuit and, if it does, replace the resistor involved.

(7) Check to insure that the three switches are in the positions indicated in subparagraph (1) above. Then measure the resistance between the EXT NET binding posts E5 and E12 by using the multimeter. The resistance should be 88 ±20 ohms.

(8) If the requirement of subparagraph (7) above is not met and the wiring is intact, L7 or C10 is defective. Check and replace any defective part.

(9) Rotate the BAL VERNIER switch, S1, successively from positions 1 through 7; measure the resistance between EXT NET binding posts E5 and E12 for each position of the switch. The resistance should increase 10 ±2 ohms each time the switch is advanced.

(10) If the requirement is not met in each case in subparagraph (9) above, check the wiring involved and, if intact, replace R5 through R10 as indicated.

(11) Before replacing a faulty resistor, check, and and clean if necessary, dirty switch contacts on BAL VERNIER switch S1.

d. Transmission Test, 2-W LINE to XMTG (fig. 28). To make a transmission test from the 2-W LINE, to the transmitting side of the 4 WIRE line, proceed as follows:

(1) Operate LF CORR switch S2 to OPEN, BO CAPACITOR switch S3 to OUT, and BAL VERNIER switch S1 to O.

(2) Connect a 600-ohm ±1% resistor to REC binding posts E1 and E2.

(3) Connect a 600-ohm ±1% resistor to EXT NET binding posts E5 and E12.

(4) Connect Signal Generator SG-15/PCM to 2-W LINE binding posts E8 and E9.

(5) Connect Decibel Meter ME-22/PCM to XMTG binding posts E15 and E16.

(6) Measure the loss at the frequencies listed below:

Frequency (cps)	Loss (db)
1,000	A = 3.0 to 4.5
12,000	(A + 1.8) ±1.5
14,000	(A + 6.5) ±3.5

(7) If the loss is too great at any frequency in subparagraph (6) above, C7 or C8 is defective. Check and replace any defective capa-

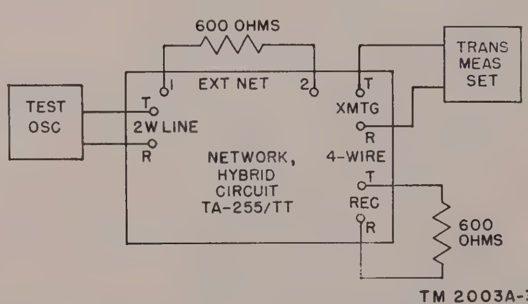


Figure 28. Connections of test equipment to Hybrid Circuit Network TA-255/TT test from 2-W LINE to XMTG line of 4 WIRE circuit.

citor. If there is not enough loss, FL1 or T2 is defective. FL1 will have the most effect at 12,000 and 14,000 cps. Check and replace any defective part.

e. Transmission Test, 2-W LINE to REC (fig. 29). Perform the transmission test from 2-W LINE binding posts E8 and E9 to the REC binding posts, E1 and E2, in the following manner:

(1) Operate the LF CORR switch, S2, to OPEN, the BO CAPACITOR switch, S3, to OUT, and the BAL VERNIER switch, S1, to O.

(2) Connect a 600-ohm ±1-percent resistor to XMTG binding posts E15 and E16.

(3) Connect a 600-ohm ±1-percent resistor to EXT NET binding posts, E5 and E12.

(4) Connect Signal Generator SG-15/PCM to 2-W LINE binding posts E8 and E9.

(5) Connect Decibel Meter ME-22/PCM to REC binding posts E1 and E2.

(6) Measure the loss at the frequencies listed below:

Frequency (cps)	Loss (db)
1,000	A = 3.0 to 4.5
12,000	(A + .7) ±1.1
14,000	(A + 1.0) ±1.4

(7) If the loss is too great in any of the readings of subparagraph (6) above, C7, C8, or T2 is defective. Check and replace any defective capacitors.

(8) If there is not enough loss as indicated in subparagraph (6) above, T1 or T2 is defective. Check hybrid transformers in accordance with subparagraph *f* below.

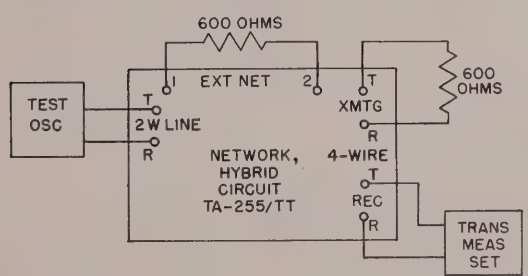


Figure 29. Connections of test equipment to Hybrid Circuit Network TA-255/TT for transmission test from 2-W LINE to REC line of 4 WIRE circuit.

f. Test of Balance of Hybrid Transformers (fig. 30). Test the balance of the hybrid transformer arrangement as follows:

(1) Operate LF CORR switch S2 to OPEN, BO CAPACITOR switch S3 to OUT, and BAL VERNIER switch S1 to O.

(2) Connect a 600-ohm ±1-percent resistor to EXT NET binding posts E5 and E12, and a second 600-ohm ±1-percent resistor to 2-W LINE binding posts E8 and E9.

(3) Connect Signal Generator SG-15/PCM to XMTG binding posts E15 and E16.

(4) Connect Decibel Meter ME-22/PCM to REC binding posts E1 and E2.

(5) Measure the loss between the XMTG and REC binding posts at 200, 2,000, and 12,000 cps, respectively.

(6) The loss should be at least 34 db at 200 cps and at least 42 db at 2,000 and 12,000 cps.

(7) If the loss is not great enough at any frequency in subparagraph (6) above, T1, T2, or FL1 is defective. Check T1, T2, and FL1 and replace any defective part.

g. Test for Low-frequency Corrector (figs. 31, 32, 33, and 34). To test the low-frequency corrector circuit, three test networks will have to be constructed in the field. Figure 31 shows test network No. 1; figure 32 shows test network No. 2 and figure 33 shows test network No. 3. Each test network is designed to simulate the line conditions for the various settings of LF CORR switch S2. The parts used in the construction of the test networks are identical with the corresponding parts used in the equipment and bear the same

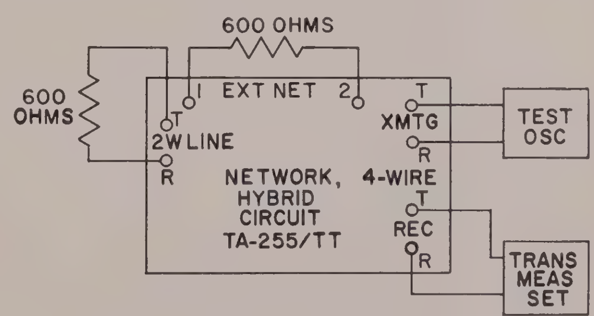


Figure 30. Connections of test equipment to Hybrid Circuit Network TA-255/TT for test of balance of hybrid transformers.

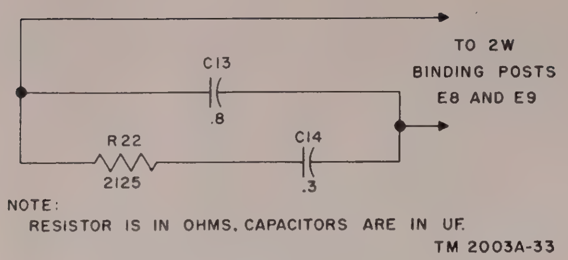


Figure 31. Test network No. 1.

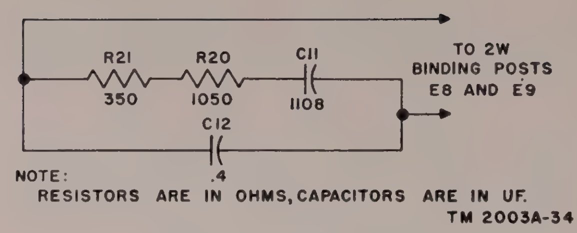


Figure 32. Test network No. 2.

reference symbols. Proceed with the test of the low-frequency circuit as follows:

(1) Operate LF CORR switch S2 to 1, BO CAPACITOR switch S3 to OUT, and BAL VERNIER switch S1 to O.

(2) Screw down all BAL RES contact posts on contact switch S4.

(3) Connect test network No. 1, figure 31, to 2-W LINE binding posts E8 and E9. (fig. 34).

(4) Connect Signal Generator SG-15/PCM to XMTG binding posts E15 and E16, and Decibel Meter ME-22/PCM to REC binding posts E1 and E2.

(5) Measure the loss between the XMTG and REC binding posts at 200, 3,000, and 12,000 cps, respectively. The loss should be at least 25 db at 200 cps, 32 db at 3,000 cps and 37 db at 12,000 cps.

(6) If the loss is not great enough at any of the frequencies indicated in subparagraph (5) above, check resistor R22 and capacitors C13 and C14 in the equipment. Replace any defective part.

(7) If the requirements of subparagraph (6) above are met, operate the LF CORR switch to 2 and replace test network No. 1 with test network 2 (fig. 32).

(8) Measure the loss between XMTG and REC binding posts at 200, 3,000, and 12,000 cps. The loss at each frequency should meet the limits given in subparagraph (5) above. If the loss at each frequency is not great enough, check resistors R20 and R21 and capacitors C11 and C12 in the equipment. Replace any defective part.

(9) If the requirements of subparagraph (8) above are met, operate the LF CORR switch, S2, to 4 and replace test network No. 2 with test network No. 3 (fig. 33).

(10) Measure the losses between XMTG and REC binding posts at 200, 3,000, and 12,000 cps. The losses should meet the limits given in subparagraph (5) above. If the loss is not great enough at each frequency, check resistors, R17, R18 and R19 and capacitor C15 in the equipment. Replace any defective part.

h. Test of Building-out Capacitor Unit (fig. 35). Test the building-out capacitor unit as follows:

(1) Operate LF CORR switch S2 to OPEN, BO CAPACITOR switch S3 to NET, and BAL VERNIER switch S1 to O.

(2) Completely unscrew all the BO CAPACITOR SEL contact posts on S5 and S6.

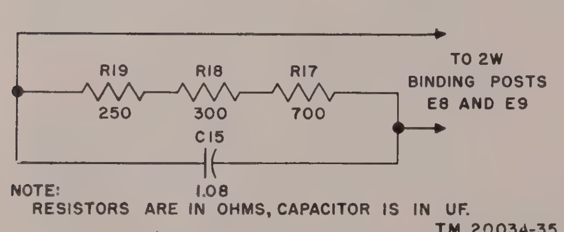


Figure 33. Test network No. 3.

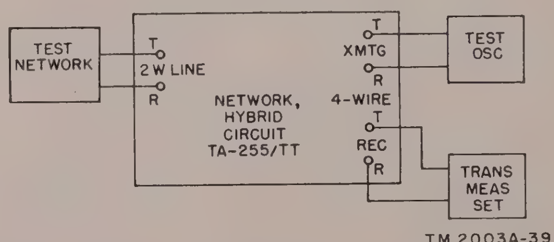


Figure 34. Connections of test equipment to Hybrid Circuit Network TA-255/TT for test of low-frequency corrector.

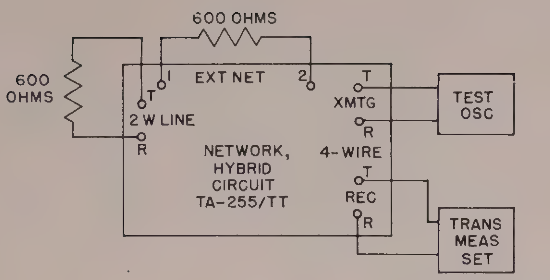


Figure 35. Connections of test equipment to Hybrid Circuit Network TA-255/TT to test the building-out capacitor unit.

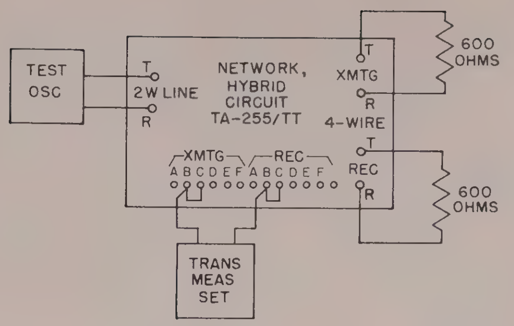


Figure 36. Connections of test equipment to Hybrid Circuit Network TA-255/TT for testing the telegraph composite set.

(3) Connect a 600-ohm ±1-percent resistor to 2W LINE binding posts E8 and E9.

(4) Connect a second 600-ohm ±1-percent resistor to EXT NET binding posts E5 and E12.

(5) Connect Signal Generator SG-15/PCM to XMTG binding posts E15 and E16.

(6) Connect Decibel Meter ME-22/PCM to REC binding posts E1 and E2.

(7) Measure the loss between the XMTG and REC binding posts at a frequency of 1,000 cps and adjust BAL VERNIER switch S1 to give maximum loss. The loss should be at least 45 db. If the loss is not great enough, check T1, T2, and FL1. Replace any defective part.

(8) Measure the loss between the XMTG and REC binding posts at the frequencies indicated below with each of the BO CAPACITOR SEL contact posts screwed down in turn. In no case should there be more than one contact post screwed down except in the case of contact posts 1 and 2.

BO CAPACITOR SEL contact post (down)	Frequency (cps)	Loss (db)
1 and 2	10,000	35 ±5
3	10,000	35 ±5
4	10,000	35 ±5
5	10,000	29 ±5
6	10,000	29 ±5
7	10,000	23 ±4
8	10,000	23 ±4
9	1,000	35 ±5
10	1,000	30 ±5

(9) If the limit is not met in each case, replace capacitor C9 and repeat measurement test of subparagraph (8) above.

(10) With BO CAPACITOR SEL contact post 10 screwed down, operate BO CAPACITOR switch S3 to LINE. The loss between the XMTG and REC binding posts at 1,000 cps should still be 30 ±5 db (subpar. (8) above).

(11) Turn BO CAPACITOR switch S3 to OUT and measure the loss between the XMTG and REC binding posts at 1,000 cps. The loss should be at least 45 db. If the loss is not great enough, check FL1, T1, and T2. Replace any defective part.

i. Test of Telegraph Composite Circuit (fig. 36). Test the telegraph composite circuit as follows:

(1) Connect a 600-ohm ±1-percent resistor to XMTG binding posts E15 and E16.

(2) Connect a 600-ohm ±1-percent resistor to REC binding posts E1 and E2.

(3) Connect terminals B and C on the XMTG side and B and C on the REC side of TG-SIG CONN terminal strip TB1.

(4) Connect Signal Generator SG-15/PCM to 2-W LINE binding posts E8 and E9.

(5) Connect Decibel Meter ME-22/PCM to terminal B on the XMTG side and terminal B on the REC side of TG-SIG CONN terminal strip TB1.

(6) Adjust the signal generator for 200-cps, 0-dbm output. Measure the loss with the decibel meter. The loss should be between 20 and 35 dbm.

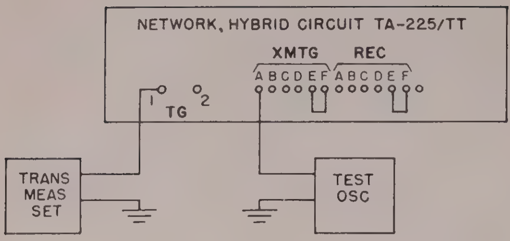


Figure 37. Connections of test equipment to Hybrid Circuit Network TA-255/TT for testing the telegraph noise filters.

(7) If the requirement of subparagraph (6) above is not met, coil L3 or L4 or capacitor C3, C4, C5, C6, C7, or C8 is defective. Check by taking resistance readings in accordance with the procedure of subparagraph *h* above, and replace any defective part.

j. Test of Telegraph Noise Filters (fig. 37). Test the telegraph noise filters as follows:

(1) Remove all straps from TG-SIG CONN terminal strip TB1.

(2) Connect terminals E and F on the XMTG side and E and F on the REC side of TG-SIG CONN terminal strip TB1.

(3) Connect the decibel meter to TG1 binding post E6 and ground. Connect the signal generator to terminal A on the XMTG side of TG-SIG CONN terminal strip TB1 and ground.

(4) Measure the loss at 300 cps. The loss should be between 15.0 and 24.5 db.

(5) If the reading is too low, coil L1 is defective. Check L1 and replace it if necessary.

(6) If the reading is too high, resistor R1 or R3 or capacitor C1 is defective. Check and replace any defective part.

(7) Connect the decibel meter to TG2 binding post E7 and ground. Connect the signal generator to terminal A on the REC side of TG-SIG CONN terminal strip TB1 and ground. Measure the loss at 300 cps. The loss should be between 15.0 and 24.5 db.

(8) If the reading is too low, coil L2 is defective. Check coil L2 and replace it if necessary.

(9) If the reading is too high, resistor R2 or R4 or capacitor C2 is defective. Check and replace any defective part.

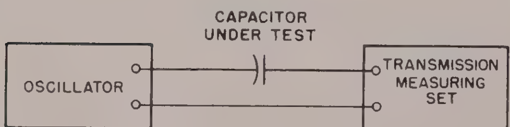


Figure 38. Set-up to test capacitors.

60. Testing Capacitors

A capacitor can be tested with Capacitor Analyzer ZM-3/U if one is available. Another method of testing capacitors, which does not require a capacitance bridge, is described below. To check a capacitor for a short, proceed as indicated in subparagraph *a* below. To check a capacitor for an open circuit, proceed as directed in subparagraph *b* below.

a. Measure the resistance between the two terminals of the capacitor with Multimeter TS-352/U. The measured resistance should be infinite, that is, the capacitor should measure the same as an open circuit if the capacitor is not shorted.

b. Connect the equipment as shown in figure 38. With the oscillator delivering 1 mw (milliwatt) at 1,000 cps, a reading should be obtained on the transmission measuring set. If no reading is obtained, the capacitor under test is open. This test is applicable only to capacitors which have a capacitance of .005 μf or more.

61. D-c Resistance of Transformers and Coils

The d-c resistances of the transformer and coil windings in the hybrid network are listed below. Make all measurements with Multimeter TS-352/U. Allow for deviations of $\pm$10 percent for all readings.

Transformer or coil	Terminal	Ohms
T1 or T2	1-2	19
	3-4	11
	5-6	19
	7-8	11
	9-10	11
	11-12	11
L1, L2, L3, L4, or L7	1-2	48
	3-4	48
L5	1-2	4.5
	3-4	4.5
FL1	1-2	.9
	3-4	.9

62. General

All the parts in the hybrid network (figs. 25 through 27) are accessible readily and are replaced easily. If a switch requires replacement, carefully mark the wires connected to the switch with tags or other devices to avoid wrong connections when the new switch is installed. The wiring diagram (fig. 43) shows the color coding of the wires. Follow this practice whenever replacement of a part requires the disconnection of numerous wires.

63. Replacement of Parts

a. To replace any rotary switch, remove the large nut which holds the switch to the panel with a hollow-shank socket wrench or a pair of long-nosed pliers. Move the switch back from the panel, and lift the switch to a position where all connections are accessible before unsoldering the connecting wires.

b. To replace contact switches S4, S5, and S6, loosen the nuts on the reverse side of the panel with a hollow-shank socket wrench or a pair of long-nosed pliers. Move the switch back from the panel, and lift the switch to a position where all connections are accessible before unsoldering the connecting wires.

c. To replace the cam-actuated fastener pins, H1 (fig. 25), at the corners of the panel, use the special pliers as shown in figure 39. Put the slotted end of the pliers around the spring sleeve and compress the spring against the head of the pin. To get the pin through the grommet hole, tilt the pin at an extreme angle as shown in the illustration. If inserted in this manner, no difficulty will be encountered. Reverse the procedure above when removing the pins.

d. To replace the grommet bushings, H2, at the four corners of the panel, a special spring holder is required. The spring holder, a tool consisting of a tapered cylinder and a short barrel, is used for installing the springs that are used to lock the grommet bushings in the panel. Figure 40 shows this tool and its operation. Place the grommet through the hole in the front of the panel and hold the grommet firmly in place with a flat piece of steel or wood. Place the tapered cylinder on the reverse side of the panel, large end down, over the bottom of the grommet. Place the locking spring on the cylinder. Place the barrel over the end of the cylinder and press down firmly until the spring snaps into the groove around the bottom of the grommet.

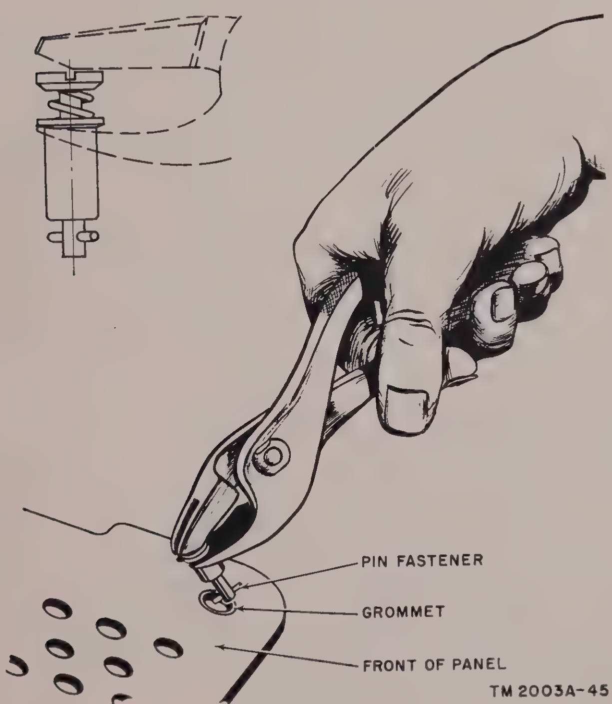


Figure 39. Method of using pin holder.

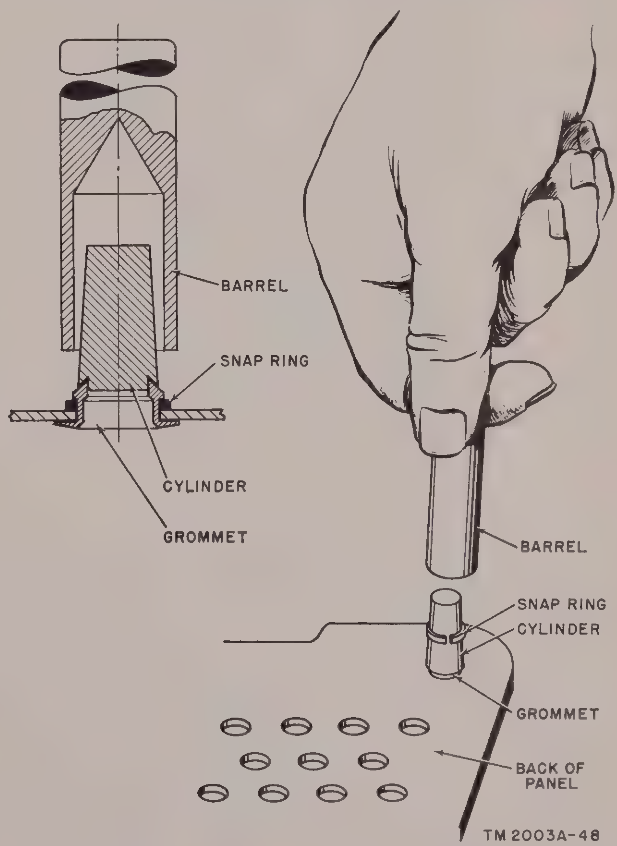
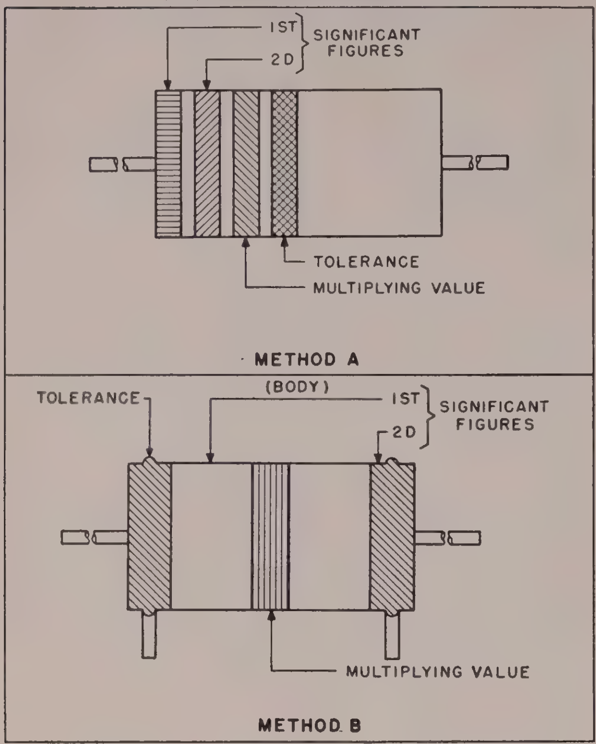


Figure 40. Method of using spring holder.

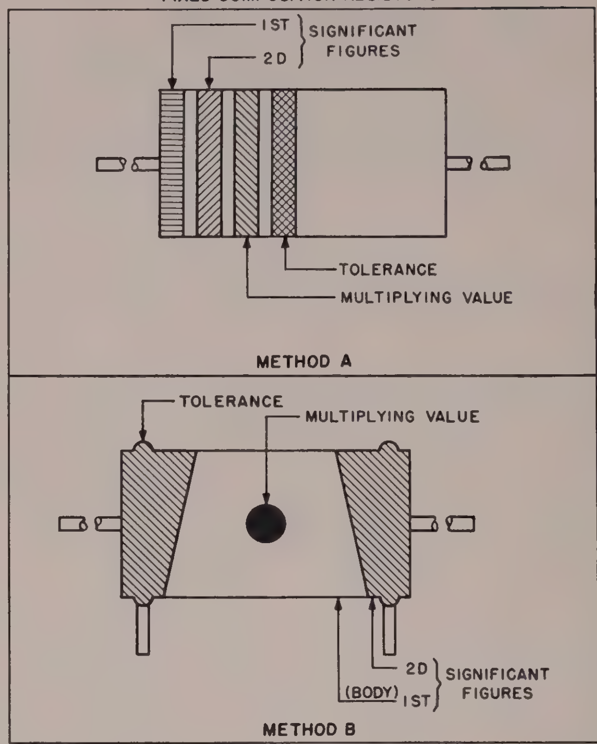
RESISTOR COLOR AND LETTER CODE

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS

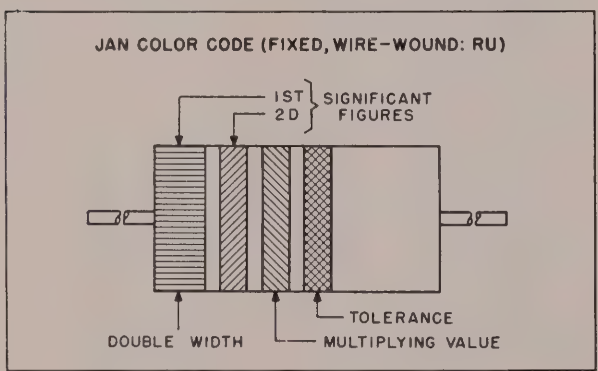


A

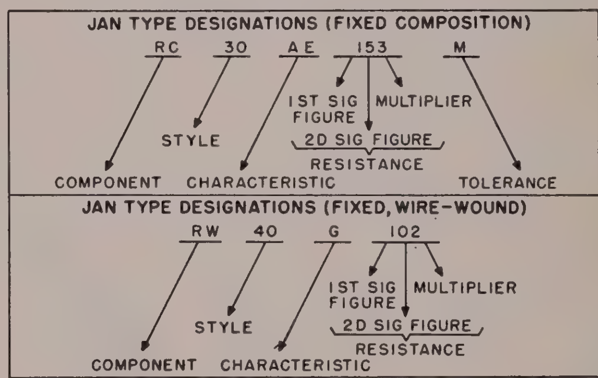
JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS



B



C



D

STANDARDS				
COLOR	SIGNIFICANT FIGURE	MULTIPLYING VALUE	TOLERANCE (%)	JAN LETTER TOLERANCE
BLACK	0	1	—	—
BROWN	1	10	± 1	F
RED	2	100	± 2	G
ORANGE	3	1,000	± 3	—
YELLOW	4	10,000	± 4	—
GREEN	5	100,000	± 5	—
BLUE	6	1,000,000	± 6	—
VIOLET	7	10,000,000	± 7	—
GRAY	8	100,000,000	± 8	—
WHITE	9	1,000,000,000	± 9	—
GOLD	—	0.1	± 5	J
SILVER	—	0.01	±10	K
NO COLOR	—	—	±20	M

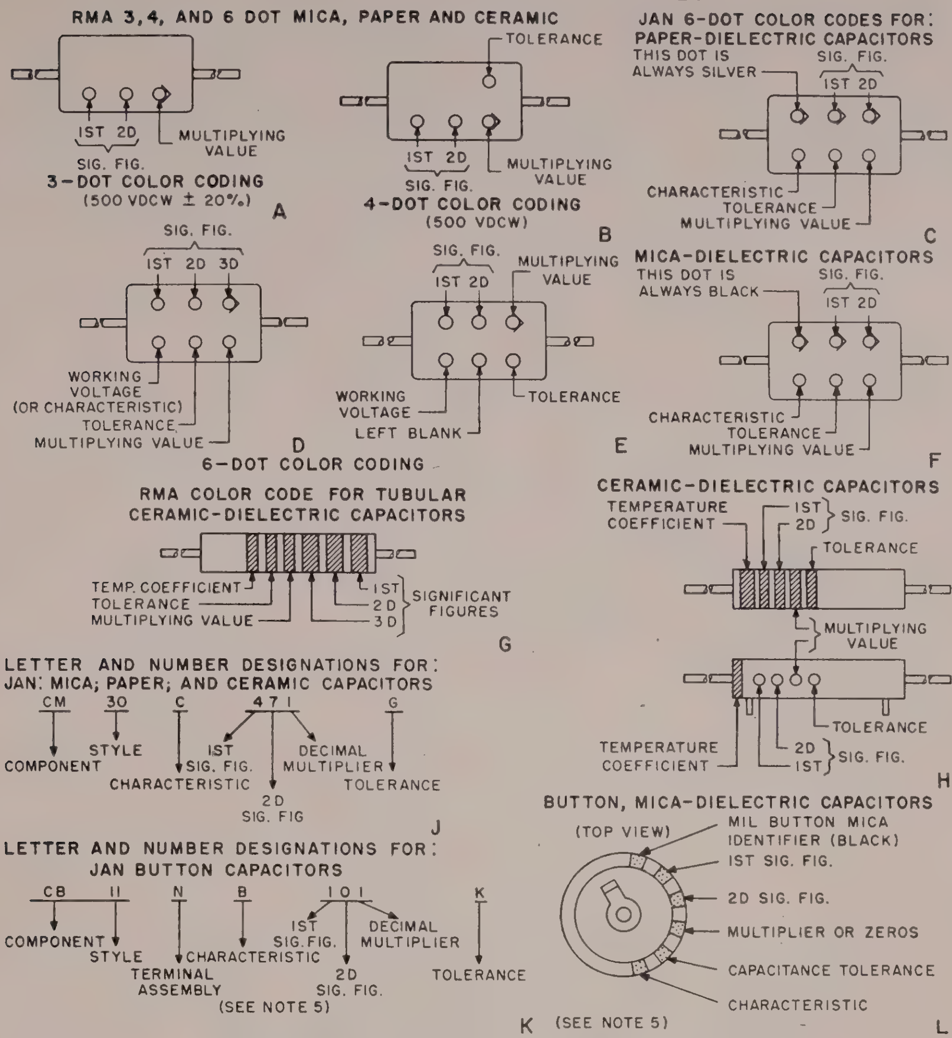
NOTES:

1. RESISTORS WITH AXIAL LEADS ARE INSULATED. RESISTORS WITH RADIAL LEADS ARE NON-INSULATED.
2. RMA: RADIO MANUFACTURERS ASSOCIATION.
3. JAN: JOINT ARMY-NAVY.
4. THESE COLOR AND NUMBER CODES GIVE ALL RESISTANCE VALUES IN OHMS.
5. RESISTIVE COMPONENTS USED FOR LETTER TOLERANCES ARE: RC, RN, AND RU.
6. WATTAGE FOR RW TYPES IS FOUND IN THE JAN SPECIFICATIONS UNDER CHARACTERISTICS.

TM RC

Figure 41. Resistor color codes.

CAPACITOR COLOR AND LETTER CODES



- STANDARDS -					JAN MICA-CM		JAN PAPER-CN		JAN CERAMIC-CC					
										CAP. TOL. FOR MORE THAN 10 UUF		CAP. TOL. FOR 10 UUF OR LESS		
COLOR	SIG. FIG.	DECIMAL MULTIPLIER	% TOL.	VDCW	LETTER TOL.	CHARAC-TERISTIC	LETTER TOL.	CHARAC-TERISTIC	DEC. MULT.	%	LETTER DESIG-NATION	UUF	LETTER DESIG-NATION	CHARAC-TERISTIC
BLACK	0	1	±20	500	M	A	M	A	1	±20	M	±2.0	G	C
BROWN	1	10	± 1	100	-	B	-	E	10	± 1	F	-	-	H
RED	2	100	± 2	200	G	C	-	H	100	± 2	G	-	-	L
ORANGE	3	1,000	± 3	300	-	D	N*	J	1,000	-	-	-	-	P
YELLOW	4	10,000	± 4	400	-	E	-	P	-	-	-	-	-	R
GREEN	5	100,000	± 5	500	-	F	-	R	-	± 5	J	±0.5	D	S
BLUE	6	1,000,000	± 6	600	-	G	-	S	-	-	-	-	-	T
VIOLET	7	10,000,000	± 7	700	-	-	-	T	-	-	-	-	-	U
GRAY	8	100,000,000	± 8	800	-	-	-	-	0.01	-	-	±0.25	C	B
WHITE	9	1,000,000,000	± 9	900	-	-	-	-	0.1	± 10	K	±1.0	F	SL
GOLD	-	0.1	± 5	1,000	J	-	-	-	-	-	-	-	-	A
SILVER	-	0.01	±10	2,000	K	-	K	-	-	-	-	-	-	-
NO COLOR	-	-	±20	500	-	-	-	-	-	-	-	-	-	-
* THE TOLERANCE OF THIS CAPACITOR IS ±30%, NOT ±3%														

NOTES

JAN: JOINT ARMY-NAVY
RMA: RADIO MANUFACTURERS ASSOCIATION

1. THESE COLOR AND LETTER CODES GIVE CAPACITANCES IN MICROMICROFARADS
2. THIS TABLE IS ADAPTED FOR JAN AND RMA COLOR AND JAN LETTER TYPE DESIGNATIONS
3. CERAMIC AND MICA CAPACITORS, BOTH JAN AND RMA, ARE GENERALLY 500 VDCW
4. BUTTON CAPACITORS ARE GENERALLY 300 VDCW
5. READ BUTTON CAPACITOR TOLERANCE UNDER CERAMICS OF MORE THAN 10 UUF
6. CHARACTERISTICS ARE AVAILABLE IN JAN CAPACITOR SPECIFICATION MANUALS
7. THE COMPONENTS USED ABOVE FOR JAN LETTER TYPE DESIGNATIONS ARE:
   CB MICA BUTTON: *CC* CERAMIC; *CM* MICA MOULDED: *CN* PAPER MOULDED

TM CC

Figure 42. Capacitor color codes.

Section IV. ALINEMENT AND FINAL TESTING

64. Alinement

Hybrid Circuit Network TA-255/TT requires no special alinement. If the equipment passes all the tests described in paragraph 59, it is ready for use in a system.

65. Final Testing

Final tests are required to determine the quality of a repaired TA-255/TT. As part of a final test, operate the equipment in accordance with the equipment performance checklist in (par. 43). Further final tests are outlined in paragraph 59.

Section IV. ALINEMENT AND FINAL TESTING

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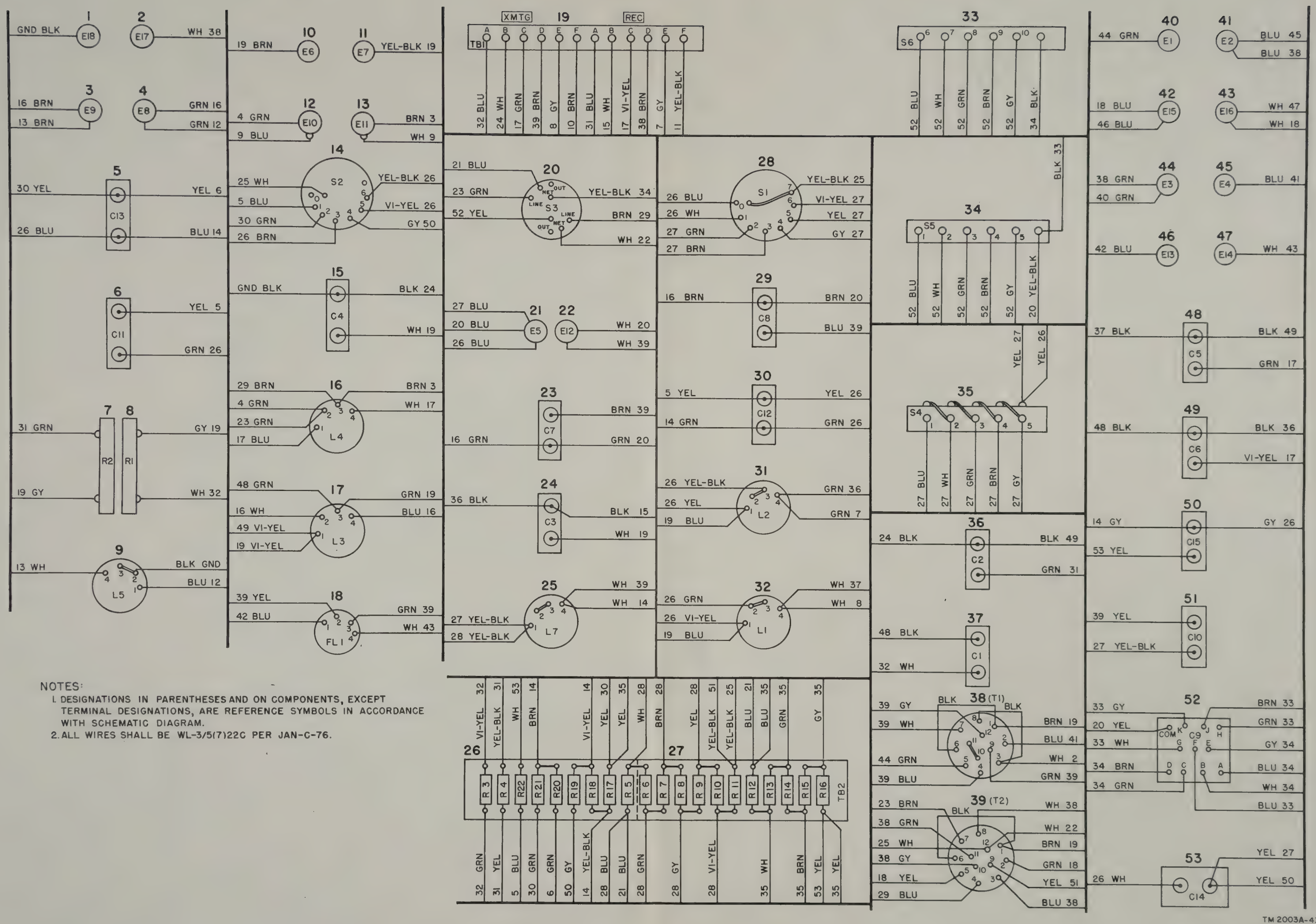

NOTES:

1. DESIGNATIONS IN PARENTHESES AND ON COMPONENTS, EXCEPT TERMINAL DESIGNATIONS, ARE REFERENCE SYMBOLS IN ACCORDANCE WITH SCHEMATIC DIAGRAM.
2. ALL WIRES SHALL BE WL-3/5(7)22C PER JAN-C-76.

Figure 43. Hybrid Circuit Network TA-255/TT, wiring diagram.

NOTES:

1. UNLESS OTHERWISE SPECIFIED RESISTANCES ARE IN OHMS, CAPACITIES ARE IN MICROFARADS.
2. SWITCHES VIEWED FROM END OPPOSITE KNOB.
3. CONNECT TERMINALS ON XMTG (TBI-A) AND REC (TBI-B) TO OBTAIN ONE D-C SIGNALING CIRCUIT AND ONE D-C TELEGRAPH CIRCUIT.

LOCATION OF SIGNALING AND TELEGRAPH EQUIPMENT	CONNECT TERMINALS ON TERMINAL STRIP			
	AT TERMINAL A OR AT RPTR TOWARD TERMINAL B		AT TERMINAL B OR AT RPTR TOWARD TERMINAL A	
	XMTG (TELEG CKT)	REC (SIG CKT)	XMTG (SIG CKT)	REC (TELEG CKT)
SIGNAL EQUIPMENT ONLY AT ASSOC CF-I(*) OR CF-3-A	C-D	C-D	C-D	C-D
WITH TELEGRAPH EQUIPMENT AND SIGNAL EQUIPMENT AT ASSOC CF-I(*) OR CF-3-A	1. A-B-C 2. D-E	C-D	C-D	1 A-B-C 2 D-E
WITH TELEGRAPH EQUIPMENT AND SIGNAL EQUIPMENT AT TA-255/TT	1. A-B-C 2. E-F	C-D	C-D	1 A-B-C 2 E-F

*REFERS TO CF-I-A OR CF-I-B

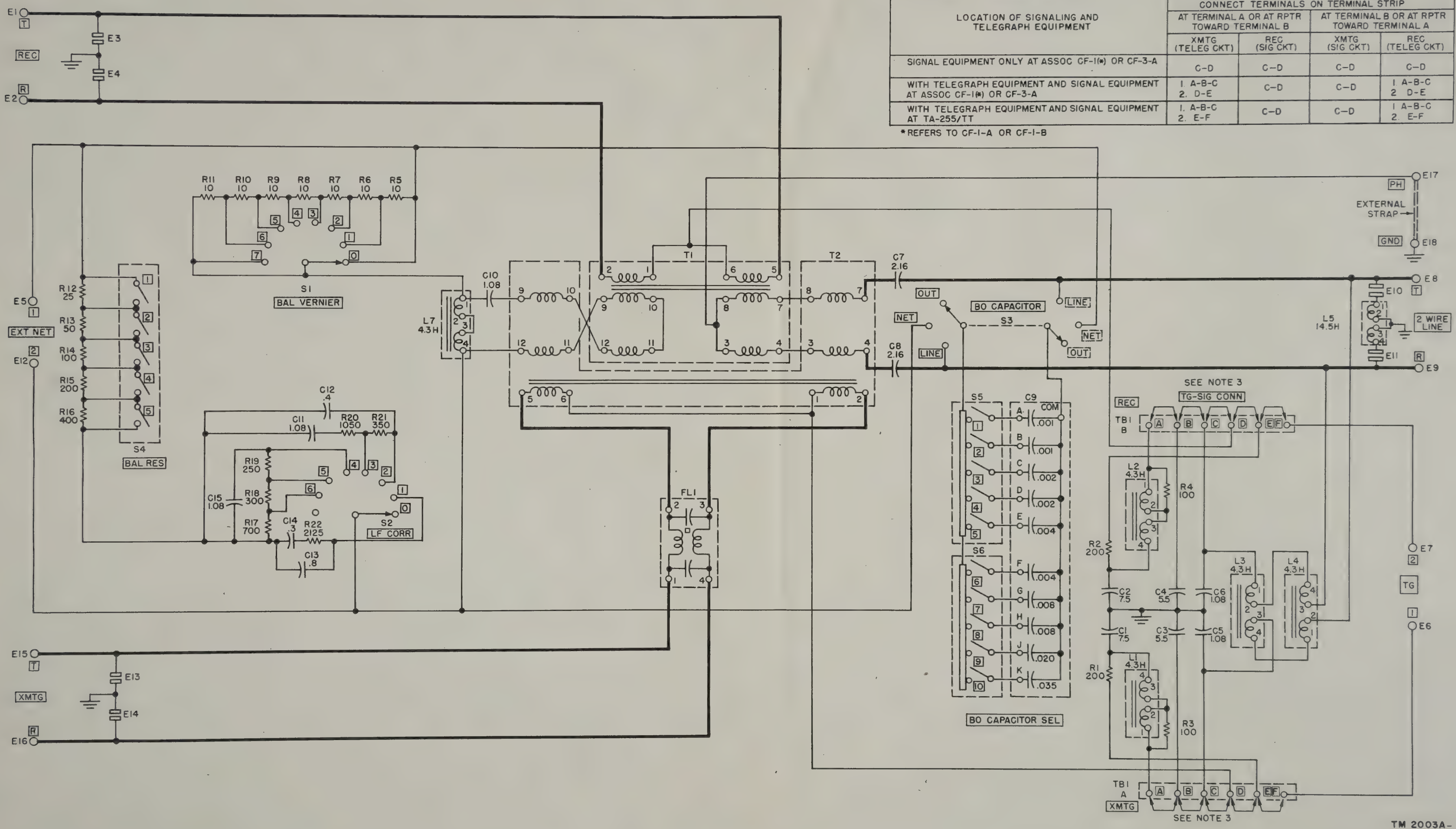

Figure 44. Hybrid Circuit Network TA-255/TT, complete schematic diagram.

CHAPTER 6

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

66. Disassembly

The following instructions are recommended as a guide for preparing Hybrid Circuit Network TA-255/TT for shipment and limited storage. To disassemble the equipment, disconnect all wires from the binding posts and reverse the procedure for setting up the equipment (par. 14).

67. Repacking for Shipment or Limited Storage

The exact procedure in repacking the TA-255/TT for shipment or limited storage depends on the materials available and the conditions under which the equipment is to be shipped or stored. The following instructions are recommended as a guide in preparing the equipment for shipment or limited storage. Refer to the uncrating, unpacking, and checking instructions in paragraph 13 and to figure 8.

a. Install new waterproof and water-vaporproof barrier materials and cushioning shroud inside the packing crate.

b. Block and brace all interior components of the equipment to prevent movement during shipment.

c. Place the equipment in the packing crate.

d. Place the salvaged waterproof and water-vaporproof barrier materials (fig. 8) over the equipment in the packing crate to form a protective shroud against possible rain penetration.

e. Fasten bags of desiccant to the sides of the equipment.

Note. When the equipment is packed for domestic shipment, the desiccant may be omitted.

f. Nail the top of the packing crate securely in place.

g. Place steel straps around the closed packing crate.

Section II. DEMOLITION TO PREVENT ENEMY USE

68. Methods of Demolition

a. Smash. Use sledges, axes, handaxes, hammers, crowbars, heavy tools.

b. Cut. Use axes, handaxes, machetes.

c. Burn. Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

d. Explode. Use firearms, grenades, TNT.

e. Dispose. Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

Note. Use anything immediately available for destruction of this equipment.

69. Destruction of Equipment

When ordered by your commander, destroy all equipment to prevent its being used or salvaged by the enemy.

a. Smash (par. 68*a*) the controls, coils, switches, capacitors and transformers.

b. Cut (par. 68*b*) wires, cords, and cables.

c. Burn (par. 68*c*) resistors, capacitors, coils, wiring and instruction books.

d. Bury or scatter (par. 68*e*) all of the above parts after they have been rendered useless.

DESTROY EVERYTHING

APPENDIX I

REFERENCES

Note. For availability of items listed, check SR 310-20-3, SR 310-20-4, and SR 310-20-5. Check Department of the Army Supply Catalog SIG 1, Introduction and Index, for Signal Corps Supply Catalogs.

1. Army Regulations

AR 380-5	Military Security (Safeguarding Security Information).
AR 750-5	Maintenance of Supplies and Equipment (Maintenance Responsibilities and Shop Operation).

2. Supply Bulletins

SB 11-47	Preparation and Submission of Requisitions for Signal Corps Supplies.

3. Test Equipment

TM 11-2019	Test Set I-49.
TM 11-2096	Test Set TS-140/PCM.
TM 11-5043	Capacitor Analyzer ZM-3/U.
TM 11-5527	Multimeter TS-352/U.

4. Painting and Preserving

TB SIG 13	Moistureproofing and Fungiproofing Signal Corps Equipment.
TM 9-2851	Painting Instructions for Field Use.

5. Camouflage, Decontamination, and Demolition

FM 5-20	Camouflage, Basic Principles.
FM 5-25	Explosives and Demolitions.
TM 3-220	Decontamination.

6. Other Publications

SR 310-20-3	Index of Training Publications.
SR 310-20-4	Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
SR 310-20-5	Index of Administrative Publications.
SR 700-45-5	Unsatisfactory Equipment Report (Reports Control Symbol CSGLD-247).
SR 745-45-5 Navy Shipping Guide, Article 1850-4 AFR 71-4	Report of Damaged or Improper Shipment (Reports Control Symbols CSGLD-66 (Army), SandA-70-6 (Navy), and AF-MC-U2 (Air Force)).
TB SIG 66	Winter Maintenance of Signal Equipment.
TB SIG 72	Tropical Maintenance of Ground Signal Equipment.
TB SIG 75	Desert Maintenance of Ground Signal Equipment.
TB SIG 123	Preventive Maintenance Practices for Ground Signal Equipment.
TB SIG 219	Operation of Signal Equipment at Low Temperatures.
TB SIG 223	Field Expedients for Wire and Radio.
TB SIG 233	Preliminary Operating Procedures for New Spiral-four Cable Assembly CX-1065/G, Telephone Cable Assemblies CX-1606/G and CX-1512/U, and Telephone Loading Coil Assembly CU-260/G.
TM 11-333	Telephones EE-8, EE-8-A, and EE-8-B.

TM 11-341	Telephone Terminal Sets TC-21-A and TC-21-B (Carrier and Repeater Set TC-23-A (Carrier)).
TM 11-369	Spiral-four Cable.
TM 11-455	Radio Fundamentals.
TM 11-2003	Carrier Hybrid CF-7.
TM 11-2008	Converter Set TC-33 and Repeater Set TC-37.
TM 11-2014	Telephone Unit EE-105.
TM 11-676	Grounding Procedure and Protective Devices.
TM 11-2601	Radio Sets AN/TRC-1, -1A, -1B, -1C, -1D, -1E, and -1G; Radio Terminal Sets AN/TRC-3, -3A, -3B, -3C, -3D, -3E, and -3G; Radio Relay Sets AN/TRC-4, -4A, -4B, -4C, -4D, -4E, and -4G; and Amplifier Equipments AN/TRA-1, -1A, -1B, -1C, and -1D.
TM 11-2262	Open Wire Pole Line Construction and Maintenance.
TM 11-2263	Lead-covered Cable Construction and Maintenance.
TM 11-4400	Telephone Terminal CF-1-A (Carrier); Repair Instructions, Operational Requirements.
TM 11-4403	Repeater CF-3-A (Carrier); Repair Instructions, Operational Requirements.

APPENDIX II

IDENTIFICATION TABLE OF PARTS

1. Requisitioning of Parts

The following is an identification table of parts for Hybrid Circuit Network TA-255/TT (Sig C stock No. 4B1467). The fact that a part is listed in paragraph 2 of this appendix is not sufficient basis for requisitioning the item. Requisitions must site an authorized basis, such as a specific T/O&E, T/A, SIG 7 & 8, list of allowances of expendable material, or another authorized supply basis. The Department of The Army Supply Catalog applicable to the equipment covered in this instruction book is SIG 7 & 8-TA-255/TT. For an index of available supply catalogs in the Signal portion of the Department of the Army Supply Catalog, see the latest issue of SIG 1, Introduction and Index.

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
E3, E4, E10, E11, E13, E14	BLOCK, telephone protector: brass cap w/carbon disk in por cyl; cylindrical shape; $\frac{21}{32}''$ lg x $\frac{1}{2}$ dia o/a.	E3, E4: Discharge abnormal line voltages across four WIRE REC line. E10, E11: Discharge abnormal line voltages across 2-W LINE. E13, E14: Discharge abnormal line voltages across four WIRE XMTG line.	4E927
TB1	BOARD, terminal: milled XP phenolic; 12 term., single-screw type; $5\frac{1}{8}''$ lg x $\frac{11}{16}''$ wd x $\frac{9}{16}''$ thk o/a.	Part of telegraph composite set; used to connect set into circuit; used to connect noise filters into circuit.	3Z770-12.154
TB2	BOARD, terminal: XXP phenolic; 40 term., solder lug type; 9″ lg x $1\frac{1}{4}''$ wd x $\frac{3}{32}''$ thk o/a.	Used to mount resistors for balancing network.	3Z770-36.34
C1, C2	CAPACITOR, paper: 1 sect.; 7.5 μf ±10%; 400 vdcw.	Parts of voice-frequency blocking circuit in the telegraph composite set.	3DB7E5
C3, C4	CAPACITOR, paper: 1 sect.; 5.5 μf ±3%; 400 vdcw.	Parts of voice-frequency blocking circuit in the telegraph noise filters.	3DB5E5
C5, C6, C10, C11, C15	CAPACITOR, paper: 1 sect.; 1.08 μf ±5%; 400 vdcw.	Parts of voice-frequency blocking circuit in the telegraph noise filters.	3DB1.930
C7, C8	CAPACITOR, paper: 1 sect.; 2.16 μf ±5%; 600 vdcw.	Block d-c path between line and hybrid transformers.	3DB2E16-4
C9	CAPACITOR paper: 10 sect.; one .035 μf, one .020 μf, two .008 μf, two .004 μf, two .002 μf, two .001 μf, 15%; 600 vdcw.	Used as building-out capacitor unit.	3DEA35-1
C12	CAPACITOR, paper: 1 sect.; .4 μf ±3%; 400 vdcw.	Compensates for variation of line impedance with frequency.	3DA400-38
C13	CAPACITOR, paper: 1 sect.; .8 μf ±3%; 400 vdcw.	Part of balancing network.	3DA800-4
C14	CAPACITOR, paper: 1 sect.; .3 μf ±3%; 400 vdcw.	Part of balancing network.	3DA300-3
L1 thru L4, L7	COIL, telephone retardation: 2 wnd; 44 ohms d-c resistance between term. 1 and 2, 44 ohms resistance between term. 3 and 4; 4 term. on cir head.	L1 thru L4: Parts of telegraph composite set. L7: Balancing network noise filter.	3C1987-39E

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
L5	COIL, telephone retardation: 2 wnd, 3.8-ohm resistance between term. 1 and 2, 3.8-ohm resistance between term. 3 and 4; 4 term.	Drainage coil on 2-W LINE.	3C1987-41
FL2	FILTER, low-pass: 12,000 cps cutoff; 600 ohms input; 600 ohms output; rectangular; metal; $2\frac{7}{16}''$ lg x $1\frac{13}{16}''$ wd x $1\frac{15}{16}''$ h o/a.	Filters line noise from XMTG terminals.	3Z1892-68.9
A2	GASKET: neoprene and cork; rectangular shape; $18\frac{1}{2}''$ lg x $9\frac{5}{16}''$ wd o/a.	Used as gasket for carrying case cover.	2Z4867.840
A4	LATCH, spring: c/o 1 base, 1 handle, 2 pin frames, 2 coil springs, 1 finger guard.	Used to hold cover to case.	6Z6918-8
E1, E2, E5 thru E9, E12, E15 thru E18	POST, binding: brass cap, silver pl, brass base; $1\frac{1}{16}''$ o/a h of post above surface, $\frac{7}{16}''$ OD of post, mtg stud 1″ lg x .190″ dia.	E1, E2: Used to connect 4-WIRE REC line. E5, E12: Used to connect EXT NET line. E6, E7: Used to connect TG set line. E8, E9: Used to connect 2 WIRE LINE. E15, E16: Used to conect 4 WIRE XMTG line. E17: Used to connect ground. E18: Used to connect phantom.	3Z761-41
E3, XE4, XE10, XE11, XE12, XE14	PROTECTOR, telephone: 1 wire cap.; o/a dimen including term. $\frac{15}{16}''$ lg x $\frac{5}{8}''$ dia across flats.	Used to mount telephone protector blocks into panel.	4E4570-1
R1, R2	RESISTOR, fixed: WW; inductive wnd; 200 ohms ±5%; 25 w.	Parts of telegraph noise filter.	3RW20152
R3, R4, R14	RESISTOR, fixed: comp; 100 ohms ±1%; ½ w.	R3, R4: Parts of telegraph noise filter. R14: Part of balancing network.	3Z6010-285
R5 thru R11	RESISTOR, fixed: comp; 10 ohms ±5%; ½ w.	Parts of balancing network.	3Z6001-165
R12	RESISTOR, fixed: comp; 25 ohms ±1%; ½ w.	Part of balancing network.	3Z6002E5-109
R13	RESISTOR, fixed: comp; 50 ohms ±1%; ½ w.	Part of balancing network.	3Z6005-216
R15	RESISTOR, fixed: comp; 200 ohms ±1%; ½ w.	Part of balancing network.	3Z6020-295
R16	RESISTOR, fixed: comp; 400 ohms ±1%; ½ w.	Part of balancing network.	3Z6040-111
R17	RESISTOR, fixed: comp; 700 ohms ±1%; ½ w.	Part of low-frequency corrector.	3Z6070-39
R18	RESISTOR, fixed: comp; 300 ohms ±1%; ½ w.	Part of low-frequency corrector.	3Z6030-152
R19	RESISTOR, fixed: comp; 250 ohms ±1%; ½ w.	Part of low-frequency corrector.	3Z6025-145
R20	RESISTOR, fixed: comp; 1050 ohms ±1%; ½ w.	Part of low-frequency corrector.	3Z6105-4
R21	RESISTOR, fixed: comp; 350 ohms ±1%; ½ w.	Part of low-frequency corrector.	3Z6035-55
R22	RESISTOR, fixed: comp; 2125 ohms ±1%; ¼ w.	Part of low-frequency corrector.	3Z6212E5-3
A3	STRAP, carrying: c/o cotton web belt 6′ lg x $1\frac{1}{2}''$ wd w/tip and tongueless belt.	Used as carrying strap for the equipment case.	6Z8448-39
S1, S2	SWITCH, rotary: 1 sect.; 8 position; single-pole, 8 throws.	E1: Part of balancing network. S2: Low-frequency corrector switch.	3Z9825-55.137
S3	SWITCH, rotary: 1 sect.; 3 positions; 2 pole, 3 throws.	Used to connect building-out capacitor into circuit.	3Z9825-66.9

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
S4	SWITCH, assembly: 5 switches, screw-down type; 10 term., solder lug type, 5 located on front, 5 located on rear.	Part of balancing network; used to connect a series of resistors into circuit.	3Z9903A-80
S5, S6	SWITCH, assembly: 5 switches, screw-down type; 6 term.	Parts of building-out capacitor unit; used to connect five sections of capacitor into circuit as needed.	3Z9903A-80.1
T1, T2	TRANSFORMER, hybrid: line type; 2 pri wnd 18 ohms ea, 4 secd wnd 9 ohms ea; ratio of turns 2-1 all wnd.	Parts of hybrid coil arrangement.	2Z9637.195

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E